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THE BULLDOG DOCKLEAF.

OUR illustration, for which we are indebted to *Black and White*, represents the celebrated bulldog Dockleaf, who lately made his *début* on the show bench at the South London Bulldog Club Show, held at the Royal Aquarium, Westminster. He is the property of Mr. Sam Woodiwiss, of Finchley, who recently purchased him from his breeder, Mr. Pybus-Sellon, for the sensational sum of £250, or $1,000, the highest price ever paid for a bulldog.

The bulldog is noted for his indomitable courage, and Stonehenge has well said that the bulldog is not only "the most courageous dog, but the most courageous animal in the world." It is a question whether the bulldog is capable of as high mental development as many other varieties of dogs. The skull, though large, is made up of many bony processes which lessen the extent of the brain cavity. A great deal that has been said in regard to the character of the bulldog is no doubt strictly true, but with proper training the bulldog is no more quarrelsome or ferocious than many other kinds of dogs. The muscles which move the jaw are abnormally developed in the bulldogs, which enables them to retain their hold in a remarkable manner; and when once they bite, it is a very difficult matter to persuade them to release their hold. As a watch dog they are unequaled, and many attempts at robbery have been frustrated by their vigilance. The massive head, the short, powerful legs, and the fierce eye will probably never render the bulldog much of a favorite; but within the last fifty years much has been done in the way of improving the shape of the dog.

DOCKLEAF, THE $1,000 BULLDOG.

THE ATLANTIC OCEAN: ITS CURRENTS.

By RICHARD BEYNON.

SOME 400 years have elapsed since the adventurous Columbus made his never-to-be-forgotten voyage from Europe to America. Then the Atlantic was indeed an unknown expanse of water. Its tides, its currents, its shallows, and its depths, together with the movements of the great air ocean superincumbent on its surface, were undetermined factors altogether hidden from those early navigators. Now, though we are in the year of grace 1892, the most traversed of the oceans has still its hidden secrets; secrets, however, from which modern science and research has partly succeeded in tearing the veil.

The steps by which our present state of knowledge has been acquired have been attended with all the pain and labor characteristic of experience gained rather by accident than design. Though much has been learned of the currents of the Atlantic through the excellent work achieved by the scientific researches conducted under the auspices of various maritime powers, it must be admitted that much knowledge has been acquired by chance, derelict vessels often demonstrating the existence of a drift hitherto unsuspected. In assessing the value of the different sources contributing to the lore of Atlantic currents, it must be admitted with regret that the British shipmaster does not take the place he should in the list of observers. It is not that his faculties of observation are one whit less acute than those of his brother navigator, German or American, for instance, nor is it that under certain conditions he does not command the leisure. If asked himself to account for what is unfortunately an established fact, he would no doubt answer that he is paid to work his ship, not to take meteorological observations. "Why should I trouble myself with sampling sea water or observing the different tints of the ocean; or would any useful purpose be served by observing the bits of floating weed that my vessel passes?" etc., etc. To which there is, of course, but one answer, viz., that the extended and systematic observation of such minutiæ with some sort of scientific exactness would tend to set at rest many vexed questions and simplify navigation very materially.

With all his virtues, the British shipmaster has one defect, and that arises from his defective education. He is not a trained observer. Those who cry out for a higher standard of education would do well to add *broader* to their demand, and make it a higher and broader educational scheme. There must be in the British merchant service an enormous fund of latent knowledge as to oceanic phenomena. If shipmasters' societies would but encourage and direct their members in the matter of scientific observation, a great and ever increasing benefit would be conferred upon our merchant service, and the sea would soon cease to be what in the main it undoubtedly is, a sealed book.

Most persons nowadays, sea going and otherwise, are familiar with the general oceanic circulation of the North Atlantic. How the mighty equatorial current, bifurcating at Cape San Roque, sends a northwesterly stream along the northern shores of the Brazils and a southeasterly one toward the southerly extremity of South America. Equally well known is the fact that the northeasterly branch of this main artery gives origin to the Gulf Stream. It is not in the province of the present paper to sketch the course of this important current, but merely to show what has been done of recent years to add to our knowledge of this and other currents of the Atlantic.

The easterly set of the waters in the North Atlantic was known to Columbus, for this intrepid navigator says: "I regard it as proved that the waters of the sea move from east to west as do the heavens (apparently, of course) *con los ceilos*." Early researches traced the Gulf Stream, as its name implies, to a home in the Gulf of Mexico. Only a small section, however, of the waters of the stream make the tour of the gulf. Captain Bartlett, of the U. S. steamship Blake, has demonstrated his observations made on the spot. What really happens is this: Between the Lesser Antilles and the South American coast, an offset from the equatorial current enters the Caribbean Sea, in the deep basin of which it is partially checked by a shore extending westward from Honduras. The current is thus turned round so as to pass eastward along the south coast of San Domingo and rejoin the main current near Porto Rico. This washes the northern shores of Porto Rico and San Domingo, and is divided by Cuba into two streams, one of which flows on its north side to the Bahama Banks, while the other passes through Bartlett Deep between Cuba and Yucatan, turning northward through Yucatan Passage, then eastward through the Florida Strait, where it unites with the other stream. Before finally issuing from the strait it is joined by the waters that have been carried into the Gulf of Mexico and have made the circuit on its shores.

The more salient features of the Gulf Stream and drift have frequently been alluded to in the pages of the *Nautical Magazine*, and charts have been published, showing the direction and duration of various bottle drifts, so that there is no need to allude to them in this paper. Considerable information has, however, been gained within a very recent period as to the immense floating seaweed area that lies in the vortex of the current sweep of the North Atlantic. Before stating what is the exact amount of present knowledge on this subject, it will not be out of place to mention on the 400th anniversary of the discovery of the new world the experiences of Columbus in connection with the Sargasso of the North Atlantic.

The existence of dense muddy coagulated seas of seaweed has ever found a place among the myths of

maritime nations. Plutarch most vigorously reproves the geographers of his day for their romantic inventions. He says of them that when their knowledge ends they rave about horrid landscapes, deserts, sky-reaching ice and *coagulated seas*. Modern experience would show that the romancing instinct is not altogether extinct among the successors to Plutarch's earth-lore seekers. Satrapes, too, is on the authority of Herodotus said to have excused his inability to circumnavigate Africa because his ship had been stopped by the "plants of the sea." Columbus, however, is the undoubted discoverer of the Sargasso Sea under discussion. He encountered quantities of floating weed (yerba) on eleven days out of the twenty-six that his famous voyage occupied. The experience of the home journey, 17th January to 17th February, 1493, was almost identical, weed being met with on nine days. "Sometimes," the great navigator wrote, "the weed comes in such compact masses as to cause the sea to look like a coagulated mass." From this description his biographers conceived and gave to the world accounts of a vast bank of fucus lying to the southwest of the Azores, and so dense as to prevent the passage of ships. These myths were long existent, and were only dispelled by the knowledge gained consequent upon the increase of trans-ocean trade. Humboldt speaks of the Sargasso as "scattered weed," an expression clearly indicative of the opinion of the author of "Cosmos" as to the origin and formation of this great weedy sea.

Our own Challenger expedition, along with those of the United States, have done much to define the limits of, and to account for, the accumulated mass of floating weed that lies in the great Atlantic vortex.

The Talisman observations, 1883, furnished much useful information, as also did the cruise of the Plankton in 1889. In addition to the information acquired by the above expeditions, Dr. O. Krummel, of Berlin, has requisitioned the log books or rather extracts from the logs of scientific observers in the German merchant service, and has been enabled to formulate many important facts respecting this the greatest of Sargasso seas.

The area of maximum weediness has been found to be an elliptical section of ocean lying south of 35° N. latitude and west of 35° W. longitude. The decrease toward the south commences at 25° N. The major axis of the ellipse, roughly speaking, lies along the Tropic of Cancer, extending from 40° W. to 73° W. The minor axis is formed by a portion of the 55th meridian, and extends from 25° N. to 35° N. latitude. Surrounding this ellipse is a well defined oval ring, six or seven degrees in width, in which the weed is more thinly distributed. Outside this area again there is another area in which the weed is of still rarer occurrence. The outermost region in which the Sargasso drift circulates has a point 52° N. and 45° W. for its most northerly limit, the Madeira for its most easterly boundary, while on the south it stretches as far south as 15° N. Professor O. Krummel endeavors to estimate the amount of surface covered with weed in each of the sections with the following results:

The region of densest weed, *i. e.*, the Sargasso Sea proper, would, he says, probably be covered with weed to an excess of 10 per cent., with a frequent occurrence of even 25 per cent. In the next belt the weed frequently would lie between 5 and 10 per cent., falling to 1 to 5 per cent. in the next zone, while in the outermost region the amount of sea surface covered by the weed would vary from three-tenths to 1 per cent.

Most interesting is the difference noticed in the various seasons. Northward from 45° N. the scattered weed is only noticed in the later summer and autumn, while in spring it disappears completely. The further south the greater frequency through all the seasons. Near 30° N. the maximum is reached in winter, and southward from the 25th parallel most weed is encountered in spring. The shores of Florida, the West India Islands, Honduras, Yucatan, and the Caribbean Sea littoral, together with certain of the Gulf States, and those immediately north of Florida, are discovered to supply the weed which is carried away by the Gulf Stream. It must not be supposed that the indraft into the Sargasso Sea secures that all the detached weeds shall find their way into the *praderias de yerva*, or seaweed meadows. Wherever the Gulf Stream exists as a defined current of any force whatever, then these weeds are sure to be found there. The coasts of France, Ireland, and even Durham, have all furnished evidences of the distances to which the Gulf weed may be carried. Much of it, too, becomes waterlogged, and sinks to the bottom, and thus does not float long enough to reach the calm area of densest Sargasso.

As to the rate at which these weeds travel, that, of course, varies at different parts of the route. Dr. O. Krummel supposes a bunch of weed detached from the Bahama Reef would make the voyage of 600 knots to Cape Hatteras in a fortnight, an average of about two knots an hour, by no means bad going, when the nature of the flotsam is considered. The next stage of the journey, 780 knots to 60° W., would take about a month to perform, the speed of the weed being now reduced one-half. From 60° W. to 40°., the rate would be reduced to half a knot per hour, and thus the 950 knots would add about two months and three weeks to the voyage. From 40° W. to the south of the Azores is about 600 knots, and the maximum speed of the weed per hour in this section of the journey would be one-third of a knot. Now the weed is in a position that it gets drawn further and further toward the vortex of the whirl. The journey would thus, from Cape Hatteras to the Azores, occupy five and a half or six months. Once in the Sargasso itself, the weed has a new feature opened to it. The area of the sea, or at least the most densely weed covered section of it, roughly coincides with the North Atlantic region of frequent calms, so that the weeds are rarely disturbed, save by an ocean swell—the reflection of some distant storm. Life swarms in this sea meadow, and the seaweed drift lives on until, waterlogged and flaccid, it slowly sinks to the bed of the ocean, thus making room for the fresh supplies of *fucus natans* that the indraft is continually withdrawing from the whirl of oceanic currents. With regard to the origin of the Sargasso weed we have stated above the coasts from which the main the supplies are derived. It was long, however, believed on the authority of the commander of the Santa Maria that the weed masked some hidden rock. Others maintained that this "social weed" grew at the bottom, and after fructification rose to the surface. One species of seaweed known as *Laminaria pyrifera* has been known to possess a stem over 850 ft. in length. This has nothing, however, to do with the Sargasso weed, whose source is now absolutely established to be that alluded to above.

The rates of Atlantic drift arrived at by the German scientists roughly approximate with those determined by Albert, Prince of Monaco. During the years 1885-6-7, His Highness made several experiments in his sailing yacht Hirondelle. In 1885 some 169 floats, weighted so as to offer no surface to the wind, were launched along a line 170 miles long in the direction of N. 14° W., from a point 110 miles from Corvo, one of the Azores. Next year 510 floats were launched on a line 510 miles long, lying along the meridian 17° 40′ W., and between 42° 34′ and 50° N. In 1887 no less than 931 floats were thrown overboard along a stretch extending from the Azores to Newfoundland. Each float was of thick glass covered with copper, with an intermediate coat of pitch, and contained a document printed in nine different languages, which invited anybody who might find one of the floats to deliver it into the hands of the nearest maritime authorities, with detailed indications as to place and date of finding. Another and smaller group of floats were sent on their voyage along a line of 128 miles lying between the two points lat. 49° 31′ N., long. 29° 7′ W., and lat. 48° 58′ N., long. 26° 7′ W. In all 227 floats found their way back to the Prince. They were found on the following shores:

Azores	37	Spain, N	14
Madeira	6	Africa, W	7
Canaries	21	Antilles	23
Iceland	3	Central America	1
Norway	22	Bermudas	4
British Isles	29	Open Sea	3
France, W	36	Various	5

Some of the floats had been voyaging for a long period when they were recovered. The recovery of 4 floats, 2 on the coast of France, after being afloat for 4 years 3 months and 5 years 3 months respectively, and 2 on Madeira, after voyages of 3 years 11 months and 4 years 2 months respectively, enables the experimenter to establish the fact that the cycle described by the objects drawn into the vortex of the waters of the North Atlantic may be renewed indefinitely, except they escape by an offset into the Arctic regions along the coasts of Ireland, Scotland, and Scandinavia.

The velocities are considered most accurate that are furnished by floats recovered on thickly populated coasts. Those which were picked up on the shores of Iceland are discarded, because the sparsity of population being so great, there is no knowing how long they have been buffeted about the coast before being found.

The mean velocity for the region comprised between the Azores, Ireland, and Norway is 3·97 nautical miles per day. Between the Azores, France, Portugal, and the Canaries, the rate of motion is 5·18 knots in the 24 hours. From the Canaries to the West Indies, the Bahamas, and even to Bermuda, it attains 10·11 knots in the day. In the eastern portion of the arc, which extends from the Bermudas to the Azores, it falls again to 6·42 miles in the same period. The mean average which the combined results give for the North Atlantic is thus 4·48 nautical miles in 24 hours.

Some information was forthcoming at the meeting of the British Association in August last, which brings information respecting the currents of the Gulf of Guinea. The facts were communicated by J. Y. Buchanan, F.R.S. The experiments were made during sounding for and actually laying a submarine cable. January, February, July, August, and September were the months in which the observations were made. The surface water of high temperature all over the Gulf of Guinea forms a layer not over 30 fathoms in thickness. Usually a moderate breeze off shore is sufficient to blow it away, and its place is taken by the denser and colder water immediately below it. The change of the water on the line from Appi to St. Thome between the seasons is most remarkable. The density of this water is higher than that of the abysmal water below it, and it is surmised that it comes from regions farther west by a return under-current. Evidences of such a current were found when experimenting close to the equator in the longitude of Ascension.

Generally the current along the Guinea coast was found to set strongly to the eastward of the well known Guinea current. In the bight near the Island of St. Thome the current set in a northwesterly direction, and was strong enough to set the ship back while heaving the sounding wire by about as much as she steamed forward between soundings. When the Buccaneer was on passage between Ascension and Conakry some interesting current observations were made in the neighborhood of the equator. Here a strong current to the eastward was found at 50 fathoms, running at the rate of 1·3 knots per hour; the surface water setting to the westward at half a knot per hour.

Bottles were thrown overboard, and four of them were recovered, the particulars of their drift being as follows:

	Days Drifting.	Position. Lat.	Position. Long.	Miles. Drifted.	Direction True.	Rate per Day.
A.	58	6° 40′ N.	12° 32′ W.			
		Picked up			East along	
		5° 47′ N.	0° 35′ E.	862	Coast.	15
B.	53	4° 40′ N.	9° 38′ W.			
		Picked up			East along	
		6° 8′ N.	1° 17′ E.	690	Coast.	13
C.	59	6° 25′ N.	14° 31′ W.			
		4° 45′ N.	8° 31′ W.	372	S. 74° E.	6·3
D.	147	0° 21′ N.	7° 37′ E.			
		3° 14′ N.	5° 57′ E.	230	N. 41° E.	1·6

Bottles A and B were thrown overboard not very far from each other in the beginning of January, and to the west of Cape Palmas. They were carried rapidly to the eastward and picked up within 3 days of each other near to Cape St. Paul. Bottle C was launched also to the west of Cape Palmas, but much farther off shore, and in the month of March it was drifted right across the routes of A and B, and was cast up on the Kroo coast. Had the same current prevailed in March as did in January, C on arriving in the track of A and B ought to have been carried like them into the bight, instead of this it never passed Cape Palmas. Bottle D was thrown overboard between the Gaboon River and St. Thome, and drifted very slowly in a northeasterly direction, and stranded near Cameroon River, having required 147 days to make good a distance of 230 miles. No doubt it covered a great deal more ground, being drifted backward and forward by the very conflicting currents of the region. More thorough investigations than these, however, are necessary to determine with exactness the set and velocity of Guinea currents; when they are assessed with accuracy, however, a great benefit will be conferred upon navigators.

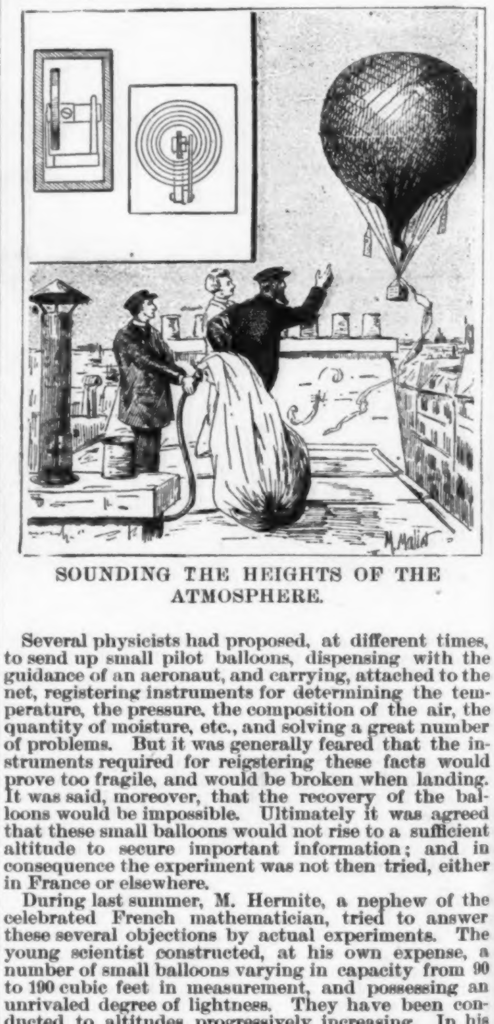
It will be noticed that in writing of the currents of the North Atlantic, or rather the latest discoveries connected with them, no allusion is made to the important work carried on by the United States Hydrographical Department. The reason is simply that the labors of this useful and beneficial department have already been dealt with in the columns of the *Nautical Magazine*.

Finality on the subject of North Atlantic currents is still far off and is likely to remain so. British shipmasters can, if they choose, do much to assist in the elucidation of many matters upon which information is yet of the vague and visionary type. If they would but interest the tedium of a long voyage with the *practical* study of oceanography, and if more of those who, like the Prince of Monaco, are possessed of wealth and leisure, would like him lend their powers in acquiring useful knowledge, much of our ignorance on the subject of ocean currents and their attendant phenomena would soon be cleared away.—*Nautical Magazine.*

AERIAL SOUNDING.

THE greatest altitude ever reached by man was attained by Mr. Glaisher on the 5th of September, 1862, when he fainted just after having taken a reading of his barometer, proving that he had then arrived at a height of 29,000 feet above the level of the sea. Since that remarkable ascent took place, several attempts were made to wrest from the celebrated fellow of the Royal Society the credit of having navigated the air at the greatest distance from Mother Earth. These several expeditions proved futile or ended in disasters.

Recording Instruments.



SOUNDING THE HEIGHTS OF THE ATMOSPHERE.

Several physicists had proposed, at different times, to send up small pilot balloons, dispensing with the guidance of an aeronaut, and carrying, attached to the net, registering instruments for determining the temperature, the pressure, the composition of the air, the quantity of moisture, etc., and solving a great number of problems. But it was generally feared that the instruments required for reigstering these facts would prove too fragile, and would be broken when landing. It was said, moreover, that the recovery of the balloons would be impossible. Ultimately it was agreed that these small balloons would not rise to a sufficient altitude to secure important information; and in consequence the experiment was not then tried, either in France or elsewhere.

During last summer, M. Hermite, a nephew of the celebrated French mathematician, tried to answer these several objections by actual experiments. The young scientist constructed, at his own expense, a number of small balloons varying in capacity from 90 to 190 cubic feet in measurement, and possessing an unrivaled degree of lightness. They have been conducted to altitudes progressively increasing. In his last experiment (27th of November) his pilot balloon rose 30,000 feet, 1,000 more than the last reading recorded by Glaisher. These balloons descended at distances enlarged in the same proportion and gradually extending to 200 miles from Paris. Almost all the balloons were returned safely by post to their proprietor through the instrumentality of school teachers of the town nearest to the landing, in conformity with the instructions printed on a card attached to the balloon. None of the instruments were broken, although some of them were made useless.

M. Hermite had invented a number of registering apparatus, so simple that their weight was reduced to a few hundred grains, and they have been shaped with such ingenuity as to bring back to the ground reliable imprints of their working. We have represented, as a specimen, his registering barometer. The registration is executed by a steel point, before which is moving a small piece of glass, blackened by smoke, which is scratched in proportion to the dilatations of the aneroid box to which it is affixed. There is no mechanism of any description, and the instrument when returned from an expedition is placed under the glass

receiver of the pneumatic pump for testing the degree of dilatation it has experienced when floating at the highest level. In the sitting of the 21st of November of the Academy of Science, before which M. Hermite had only attained an altitude of 28,000 feet, M. Berthelot, the perpetual secretary, eulogized the method, and, after having printed the results obtained in the *Comptes Rendus*, referred M. Hermite's paper to the balloon committee for further examination.

The balloon of the 27th of November, which was found at and returned from Ste. Florence, Canton des Essarts, at 350 kil. from Paris, was sent up by M. Hermite from the top of the house where are located the offices of the *Ecole Superieure de Navigation Aerienne*, 113 Boulevard de Sebastopol. He is now constructing a larger balloon, twenty-four times bigger, which is expected to be able to reach an altitude of a little less than 40,000 feet. The operation will take place within a few days at La Villette gas works, the site of every aeronautical experiment of importance in Paris. Commander Renard, the head of the Natins-Meudon establishment, will send the imitation pilot balloon of his make and registering apparatus organized by him, it remains to be seen with what success.—*Daily Graphic.*

PHOTOGRAPHS OF SWIFT'S COMET.

By Prof. E. E. BARNARD, of the Lick Observatory.

THESE three photographs, selected from a series and enlarged 2¼ times, clearly show the remarkable changes the comet was subject to when near perihelion. A brief description of the pictures, pending a more detailed discussion, may not be out of place here.

These were made with the 6 in. Willard lens, strapped on to the tube of the 6½ in. equatorial, which was used as a following telescope. The focus of the Willard lens is 31 inches. As the comet was moving rapidly among the stars, the clock-work, which corrects for the ordinary diurnal motion, would not serve to follow the comet. The nucleus was therefore brought to the intersection of cross wires, a high power eye-piece being used on the 6½ in., and the telescope was constantly shifted by hand with the slow motion rods, so that the nucleus was always kept perfectly bisected, the clock simply correcting for the diurnal motion. The light of the comet seems to have been very strongly actinic, as will be seen from the amount of detail shown with comparatively short exposures, very little of which could be seen with the eye and telescope. Cloudy weather interfered greatly throughout the time of the comet's greatest brightness. After a long cloudy spell, I had examined the comet on April 3, when its tail was traceable for 20° with the naked eye. The 12 in. achromatic showed the tail, near the head, to consist of two thin streams of slightly divergent light, with scarcely any nebulosity between. There was certainly no third stream.

THE PHOTOGRAPHS.

April 4, 15h. 30m.–16h. 30m.—It will be seen in this picture that a third branch had made its appearance since the 3d, in between the two previously seen. This central branch is shown in the photograph to be crested with a fine bright line, more or less curved and broken. For a short distance from the head a second line lies close by and parallel to it. To the north of the northern branch there are one or two hair-like, dark spaces, which appear darker than the sky near; they are doubtless simple rifts in faint diffused nebulosity surrounding the comet. It will be seen that the tails of the comet readily break up into quite a number of separate branches at some distance from the head. The star trails, representing the direction and amount of motion of the comet during the exposure, are pear-shaped in this picture. This is due to the fact that the exposure was begun when the comet was near the horizon and the light of the stars was more or less absorbed by the dense atmosphere. This peculiarity serves to mark the beginning of the exposure and the direction of motion of the comet, the motion being in the direction of the large end of the trail.

April 6, 15h. 35m.–16h. 40m.—This picture shows the remarkable changes undergone by the comet in the short interval of two days. There is very little or no resemblance in the comet for the two dates. It will be seen that the separation in the tail makes a rather quick bend near the head. There are unequal bright areas in the main tail, some of which are suggestive of the remarkable changes seen in the picture for April 7. There is a little incident connected with the history of this photograph of the 6th of April that may be of popular interest. On this date it was necessary for me to go to San Jose to fulfill an engagement to lecture that night (being one of a series of six lectures for the University extension). After the lecture, at 10h. 30m. P. M., I hired a horse and buggy and drove up the mountain, 27 miles, arriving at the observatory at 2:30 A. M., and between that time and dawn secured this photograph. On this date, to the naked eye, the tail was about 25° long, the head being equal to a star of the first magnitude.

April 7, 15h. 45m.–16h. 35m.—This photograph was made partly in moonlight and partly in dawn. I need scarcely call attention to the unique appearance of the tail on this occasion. There is still less resemblance to the former appearance of the comet in the short interval of 24 hours. A number of narrow branches are now shown in the tail near the head, the middle or main one of which has a curve in it some distance from the head. The most remarkable and unique phenomenon, however, is the apparent development of a secondary comet 2° behind the head in the main branch. There is at this point a great enlargement or swelling, which is gradually brighter in the middle, and from which a new system of tails seems to branch out. A photograph made the next morning in full moonlight showed only a portion of the tail close to the head, the sky being too bright for the photography of faint objects. The scale of these enlargements is 1 inch = 1·2°.

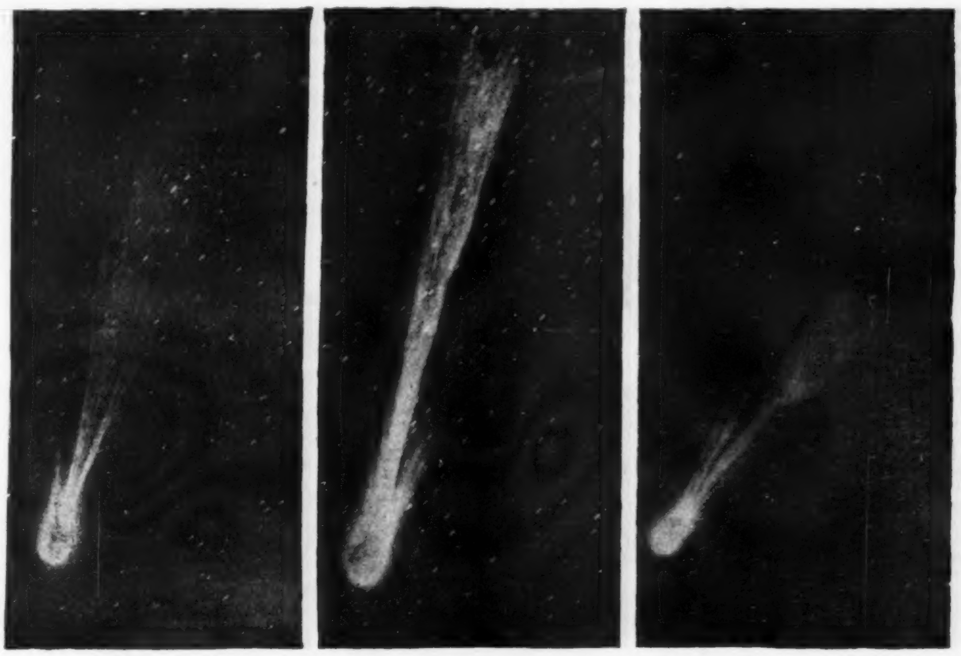
It seems to me that these photographs are a revelation to us. We are familiar with the rapid changes that comets sometimes undergo, but if these three pictures, so close together in point of time, had been drawn by the most competent observer, most astronomers would probably have attributed their remarkable differences to the unskillful hand of the artist, for there is absolutely no resemblance among them. The accuracy of the photographic plate, however, is unquestionable, and these pictures therefore give us an insight into the rapidity and vastness of cometary changes little dreamed of before.

In examining this series of photographs the idea has been very forcibly impressed upon me that there was possibly, in the case of this comet, a rotation of the tail upon an axis through the nucleus, in a comparatively short period. It is to be regretted that cloudy weather broke the series to such an extent that it is not possible to settle this question; still it is a point that must be closely looked after in our next large comet.

Mount Hamilton, August 31, 1892. —*Knowledge.*

WEST.

4th April, 1892.—Exposure. 1 h. 6th April, 1892.—Exposure, 1 h. 5 m. 7th April, 1892.—Exposure, 50 m.



PHOTOGRAPHS OF SWIFT'S COMET.

(Taken by Professor E. E. Barnard at the Lick Observatory with a 6 inch camera of 31 inches focus.)

The stars are represented by short lines parallel to the direction of the comet's motion, as the camera was made to follow the motion of the comet and not the diurnal motion of the stars.

ON THE FORMS OF COMETS' TAILS.

By A. C. RANYARD.

THE beautiful photographs, for which we have to thank Prof. Barnard, show some remarkable irregularities in the streams of matter driven away from the nucleus and from the sun. There is not merely a variation in the brightness or density of different parts of the tail, such as might be caused by the matter being driven away from the nucleus in varying quantities at successive instants, but the edges of some of the streamers appear to be distinctly curved or bent in an irregular manner. This is particularly noticeable in the southern edge of the great streamer, photographed on the 6th of April.

We do not know how far the photographic record obtained may be affected by the motion of the matter of the tail during the 65 minutes for which the photographic plate was exposed, but any motion of a bright mass of matter in the tail in a direction away from the comet's head during the exposure would tend to obliterate such irregularities, and give a straighter appearance to the streamers or jets.

There can be no doubt about the existence of the irregularities referred to. The southern (or right hand) edge of the great streamer, photographed on the 6th of April, is very distinctly notched or bent inward at a distance of about 4° (that is, at a distance of about 3½ inches on the scale of our plate) from the nucleus. A little above the notch the narrow stream of luminous matter which forms the southern edge of the great streamer divides into two, or forks. This is clearly shown in our plate at a distance of about 5 inches from the nucleus, and it is still more clearly shown on the glass enlargement from the original negative which Prof. Barnard has kindly sent to me. There is also just traceable on the plate, and distinctly visible on the glass enlargement, a narrow stream on the inner or northern side of this branching structure, and several faint structures which appear to branch or fork somewhat after the manner of the structure on the edge of the great streamer.

There is also a distinct bend in the edge of the great streamer of the 6th of April nearer the nucleus at the place where it divides from the fainter group of rays which form the southern half of the comet's tail. The division between the great streamer which forms the northern half of the tail and the group of rays which forms the southern half is continued as a very narrow black line toward the nucleus, and this line makes a very obtuse angle with the rest of the southern edge of the great streamer. On the northern side of this narrow dark line is a bright forked structure, the branches of which trend away from the nucleus, similarly to the branches of the forked structure referred to above.

The branching structure last described has, as shown on Prof. Barnard's glass enlargement, a form which reminds one of a solar prominence, and it gives a clew which may possibly explain the irregularities in the edges of the streamers. If during the rapid evolution of vapors in the neighborhood of the nucleus gas is evolved in irregular or intermittent quantities, and is projected outward, we should expect an uprushing mass of gas in passing through a resisting medium or atmosphere about the cometary nucleus to take the tree-like prominence forms which uprushing masses of gas take upon the sun, and such prominence forms, as they are driven away from the sun and nucleus, would give rise to irregularities in the edges of the streamers as well as to the mottled appearance of the tail which we see in Prof. Barnard's photographs.

In a waterfall the foam on the surface tends to arrange itself into parabola-like curves with the apex downward, because the stream is retarded at its edges, and a wave on the surface or any other line across the stream moves more rapidly at the center than at the edges of the stream, but there are no such transverse markings in the mottling of the tail of Swift's comet. The mottling seems to be disposed in irregular masses, with here and there an appearance of branching in a direction away from the nucleus. Such irregularities are worthy of the closest study, because deviations from general laws have always formed stepping stones to further discovery.

Our first step is to make sure of facts. There can be little doubt that there is a decided bend in the lower part of the main stream photographed on the 7th of April, about half way between the nucleus and the curious knot or branch in the main streamer, which Prof. Barnard describes as a second comet; possibly it may have been a secondary or attendant comet, seen through the tail of the large one, for such attendant comets have been observed before, though, as far as I am aware, they have not appeared in the midst of the tail of a large comet and, apparently, intimately associated with one of its streamers. The fact which chiefly weighs with me in concluding that the structure was probably a second comet is that the bright point which seems to form the nucleus of the little comet is not stretched out into a line by the motion of the camera in following the large comet—as all the stars are. The nucleus of the little comet was therefore a bright point which was moving with the large comet. But the rest of the small cometary structure has very much the appearance of being an irregular branch from the main streamer of the large comet.

It is much to be regretted that we have not other photographs taken an hour or two before and an hour or two after Prof. Barnard's photograph on the 7th of April, and it would also have greatly added to the interest of his work if Prof. Barnard had taken photographs of the comet with short exposures of a few minutes before and after the long exposures. We should then, no doubt, have been able to trace more structure in the head or nucleus of the comet, which is now obliterated by the long exposure. But Prof. Barnard did not expect to find the light of the comet so actinic. Curious irregularities have been noticed in the tails of other comets, notably in the tail of the great comet of 1882. There is a curious increase of brightness and striation toward the end of its tail, which was drawn by more than one observer and was photographed on October 20 at the Cape Observatory. The original negatives of this comet have been deposited by Dr. Gill in the library of the Astronomical Society at Burlington House, and are well worthy of examination.

There is evidence which can hardly be doubted tending to show that the tail of Donati's great comet, which appeared in 1858, did not lie accurately in the plane of its orbit. According to Prof. G. P. Bond, who collated the drawings and observations of a great number of European and American observers of this comet, and discussed them in a very valuable monograph which was published as Vol. III. of the "Harvard Annals," the axis of the tail of the comet was inclined at an angle of nearly 4° to the plane of its orbit; and during nearly the whole of its apparition there was a contrast in the density of the two branches of the tail, which remained unchanged when the earth

passed through the plane of the comet's orbit on the 8th of September—a fact which points to the conclusion that there was no revolution about an axis, of the nucleus, or swarm of stones, from which the streams of matter forming the tail issued.

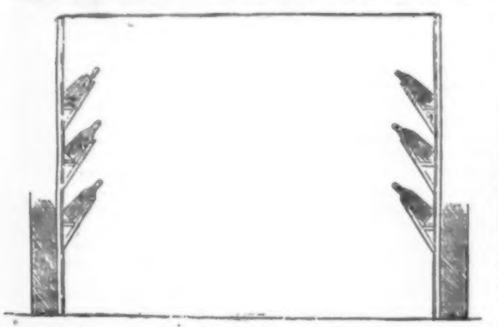
The curvature of the tail or tails (for Donati's comet had three), as well as the gradual decrease of density of the tail with increase of distance from the nucleus, points to the conclusion that matter is continually streaming away from the nucleus, and is driven away from the sun. Matter driven backward into space with very great velocity, compared with the velocity of the nucleus in its orbit, would evidently form a nearly straight tail in the prolongation of the radius vector (or line joining the nucleus with the sun), while matter driven backward with a velocity comparable with the velocity of the nucleus would drop behind the radius vector, and form a tail curving backward in the plane of the orbit, the curvature being more and more apparent the slower the velocity with which the matter of the tail was driven away. Thus the different curvatures of the tails of comets exhibiting more than one tail is accounted for.

Prof. Bredichin, whose theory has been much quoted, is inclined to call in an unknown electrical repulsion, differing for different materials, to account for the different velocities of repulsion, and the different curvatures of cometary tails.

The particles of which comets' tails are composed are evidently very small, for they are small in average diameter compared with the wave-length of light—this is rendered evident by the fact that the light dispersed of comets' tails (except in the neighborhood of the nucleus, where a gaseous spectrum is recognizable) is generally strongly polarized—and it seems to me that we may satisfactorily account for the repulsion of such small particles from the sun without calling to our aid any unknown force, but by merely considering the repulsion which would be caused by evaporation taking place from the side of the particles exposed toward the sun. In a paper published in *Knowledge* for February 16, 1883, I have discussed the accumulated effect of the minute recoils which must accompany evaporation as one molecule after another is thrown off from the surface of a small heated body toward the sun. When three-fourths of a heated particle have been thus evaporated toward the sun, the velocity of the remaining one-fourth away from the sun would be greater than the molecular velocity of evaporation, but the irregularities in the tails of comets referred to above show that we have other forces to consider, which slightly vary the form that cometary tails would assume if the matter of the tail were only acted upon by repulsive forces, in directions away from the sun and away from the nucleus.—*Knowledge.*

KEEPING GRAPES.

WILL some reader kindly tell me the best kind of house to put up for keeping grapes as long as possible, as I am afraid I shall not be able to keep them long in

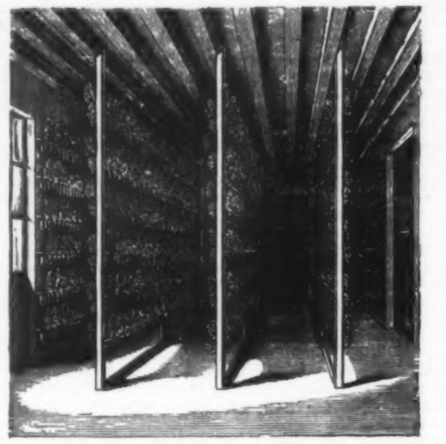


SECTION OF GRAPE ROOM AT HECKFIELD.

my present room, which is over a stoke hole, and generally stands at 60°? I have just taken out one row of glass from the windows and put in perforated zinc to cool it, but am afraid there will be too much air, as a correspondent in a recent issue said that a cool, dry close room was necessary. My grapes are mostly Gros Colman and a few Alicante. I suppose it is useless now to build a proper room this season, being too late to get dry. I want to keep 600 or 700 lb. to market about March if possible, prices being so low now. —G. C. S.

A room over a stoke hole is anything but a good position for storing grapes in, especially if the temperature stands so high as 60°. From 45° to 50° has been repeatedly proved to best meet the case, and a room that keeps near these figures without either the assistance of much fire heat or the admittance of air is most desirable. The best place I have yet found for keeping grapes in is a spare bed room in a large old house. This is on the north side, has thick hollow walls, and is duly ceiled. There is a fire place in it, but this is only used during the prevalence of very severe weather, being blocked up at all other times. There is a tight fitting shutter to the window, and this is seldom opened, while the door is also kept locked.

It will be found that grapes in still warmer houses or rooms are constantly cool, and which can be more surely tested by placing a berry against the cheek, and in the comparatively low temperature of a fruit room they are still colder. If a room is ventilated freely directly after a change from very cold to quite warm weather, the warm air quickly condenses on the cold walls, the moisture trickling down in streams, and we are told that this is simply the frost coming out of the walls. Much the same thing is liable to happen if warm air from the outside, and which is naturally highly charged with moisture, comes into contact with the grapes, and once the skins have been damaged in that way, decay of the berries is inevitable and rapid. That is why grapes keep so much better in a cool, properly constructed room than in a vinery, where much greater fluctuations of temperature and free ventilation at times are unavoidable. It is surprising what a great number of bunches may be hung in a small room, a series of simple racks formed so as to support half-pint bottles in a sloping direction being all that is necessary on each side of the room. Mr. Robinson in his work on the "Parks and Gardens of Paris" first drew attention to the simplicity and effectiveness of this plan of keeping grapes, and the simple woodcuts here given will do more toward instructing "G. C. S." than any number of paragraphs from my pen. A bed room not being available, then ought "G. C. S." and others who are anxious to keep a large quantity of grapes till the spring, or, say, up to May, to construct a building specially for the purpose. In some instances



INTERIOR OF GRAPE ROOM AT THOMERY.

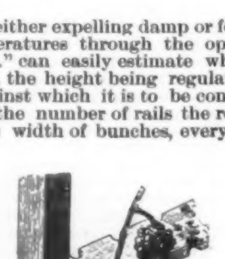
it might be possible to convert a lean-to shed on the north side of a wall into a grape room, a wooden floor being formed, the walls thatched, and the roof either ceiled inside or thatched on the outside. If necessary a room could be built against a north wall preferably as being the coolest site and least affected by fluctuations of temperature, the side being either a wall of hollow brick or stone, or of wooden posts and match boarding,

FERRIERE MODE OF FIXING THE BOTTLES.

a heavy thatch of either straw, reeds, or heath being necessary in this case. The roof should be either slated and ceiled, or better still, slated and thatched. What light is needed at different times can best be admitted by either a hinged top light or from one end, this being covered up as a rule. A single hot water pipe carried round the room might be serviceable at times for

MR. DODD'S TUBE FOR GRAPES.

the purpose of either expelling damp or for preventing very low temperatures through the opening in the roof. "G. C. S." can easily estimate what length his room should be, the height being regulated according to the wall against which it is to be constructed, and the length by the number of rails the room will hold and the average width of bunches, every bunch being



THOMERY MODE OF FIXING THE BOTTLES.

allowed to swing just clear of its neighbors. I can only advise "G. C. S." to place a layer of perfectly dry ashes or some other non-conducting material between the brickwork of the stoke hole and the flooring of his room, and if the flue passes through the room, to divert this if possible.—*W. I. in The Garden.*

PROPAGATION OF CHERRIES.

Budding.—Cherries are propagated for commercial purposes almost entirely by budding. This consists of transferring a single bud of the desired variety to the stock or branch upon which it is to grow. The operation is usually performed during the month of August when (using a nurseryman's phrase) "the bark slips." It is effected by slicing a well ripened bud from a twig of the growth of the same season, and inserting it under the bark of the stock, where it is securely tied. If the operation is successful all the top above the inserted bud is cut off the following spring. By rubbing off and preventing the formation of other wood the whole growth of the stock is directed into this channel. In this way trees of suitable size for orchard planting are produced in two seasons. In the Western States where the snow fall is limited some objections have been urged against this method of propagation on the ground of the prevalence of root injury to the more or less tender stocks. In regions of abundant snow fall, as in the Province of Quebec and Eastern Ontario, this objection does not carry the same weight.

CROWN GRAFTING.

Root grafting as ordinarily practiced when applied to the propagation of the cherry is attended with little success.

Crown grafting, which is inserting the scion in the crown or collar of the stock, at or a little below the surface of the ground, is in the experience of the writer a much more successful method. This may be done in winter, using stocks which have been stored for the purpose; or early in spring upon stocks already established, and undisturbed in the ground for a year. Prof. Budd claims satisfactory results when the stocks are taken up in the autumn and grafted in the graft room during winter. Careful comparisons have been made here for the past three years with a view to determine which plan was attended with the best

results. The average returns show a gain of over 50 per cent. in favor of crown grafting, early in spring, upon stocks in the ground, which had been planted the year previous. A strong growth is obtained the first year, at the end of which the graft may be taken up and part of the old root cut away. The yearling graft may then be replanted, setting it deeper than formerly, so that the scion is brought under ground and offered conditions favorable to the emission of roots. The principal objection to the method is that at the time—early in spring—when this work should be performed many other duties engage the attention of the fruit grower, making it difficult to accomplish in a limited time a large amount of this kind of grafting. The method is one, however, that can always be practiced to some extent. It will prove of special service to amateurs, for whose benefit the following instructions are given:

The stocks should be planted in nursery rows the year previous to the date of grafting. Cut well matured scions in autumn of the growth of the same season, keep these in a dormant condition over winter by packing in forest leaves or damp sawdust. In this locality the best time for out-door grafting is usually during the first two weeks of April. The cut shows the method of crown-grafting the cherry, as usually conducted in the graft room; (*a*) shows the scion cut wedge-shape, (*b*) the stock with a slanting cleft for the reception of the scion, (*c*) the scion in position, firmly bound with waxed thread, and (*d*) illustrates the joint completed by a covering of grafting wax to exclude the air.

In the case of out-door work the process is essentially the same, except in the manner of tying. Instead of binding first and waxing afterward, a firmer joint is made by applying the wax first, and covering this with a cotton bandage which adheres to the wax and holds the scion in position. It must be remembered in the case of stocks which are in the ground that the top is cut off at the point indicated in the figure as soon as the scion is inserted. After a little practice this is easily removed by an upward cut, which can be made without disturbing the scion.

PROPAGATION BY ROOT CUTTINGS.

When cherries are on their own roots, as when grown from sprouts, they may be multiplied by means of root cuttings. The surface system of roots—those nearest the top of the ground—are used for this purpose. These are taken up in the autumn and cut into 3 in. lengths, packed in boxes with earth, and stored in a cool cellar till spring. When the ground is in proper condition the cuttings are planted in rows, sticking them in a slanting position and covering completely, so that the top end is about an inch below the surface of the soil. Several shoots will usually start; the strongest should be trained up to form the future stem, and all others broken off. Where greenhouse facilities are available, the cuttings may be started during winter with gentle bottom heat in the propagating bench, and set in nursery rows the following spring.

GRAFTING WAX.

Many receipts are offered for the manufacture of grafting wax. A satisfactory wax for outdoor use is made by melting together 5 parts resin and 2 parts beeswax; to this is added 1½ to 2 parts linseed oil. For winter use in the grafting room the same amount of resin with less oil and beeswax makes a wax more suitable for indoor application.

A liquid grafting wax is made by melting together 1 lb. white resin and 1 oz. beef tallow; to this, when removed from the fire and partly cooled, 8 ounces of alcohol is added, stirring in slowly. This should be kept in closed cans to prevent the alcohol evaporating.—*Bulletin Central Exp. Farm, Canada.*

A SANITARIAN'S TRAVELS.

MR. ROBERT BOYLE has traveled round the world no fewer than four times for the purpose of studying sanitary science and preparing the way for the introduction of the ventilating and sanitary appliances he has invented. An interesting account of his fourth journey is given in a little book entitled "A Sanitary Crusade through the East and Australasia," consisting of a series of papers reprinted from the *Building News.*

GREAT RECUMBENT FIGURE OF BUDDHA, PEGU, BURMAH.

In the course of this "crusade" Mr. Boyle visited Burmah, the Malay native states, Sumatra, Siam, Borneo, Java, Australia, New Zealand, Samoa, the Sandwich Islands, and America. Of all the facts noted by him as a sanitarian, the most remarkable are those relating to leprosy, a disease which he believes to be spreading to an alarming extent all over the world. He was particularly struck by the gigantic proportions the evil has assumed in Burmah. The steps of the great Shwedagon pagoda at Rangoon, the Mecca of the Indo-Chinese Buddhists, he found to be "closely lined from top to bottom with lepers, suffering from that loathsome disease in its worst forms and most advanced stages." A number of the victims examined by Mr. Boyle "presented a most sickening and awful spectacle." Yet no provision worthy of the name appears to be made for the maintenance or treatment of these poor lepers, who are thus compelled to resort to begging to keep themselves in existence. At Mandalay Mr. Boyle came in contact with horrors of a similar nature. During times of high festival the entrances of the great Arakan pagoda in that city are crowded by hundreds of lepers, so that the visitor has to pick his way carefully among them. In the Sandwich Islands also Mr. Boyle was strongly impressed by the terrible effects of the curse of leprosy, which, he says, has nearly decimated the native population.

He has a curious theory to the effect that the propagation of leprosy has been to a large extent connected with cannibalism, the disease "being spread wholesale through the eating of infected bodies." He has frequently seen in New Caledonia and the South Sea Islands human bodies "hanging up in the natives' huts, intended for future repasts, though then in an advanced stage of decomposition and exhaling a sickening odor."

The little book is by no means occupied only with these terrible subjects. Reference is made to many interesting things which came under Mr. Boyle's observation in the course of his journey. We may especially note the impression produced upon him by Buddhist temples and various classes of objects associated with Buddhism in Burmah. Pagan, an ancient capital of Burmah, situated on the Irrawaddy, between Mandalay and Rangoon, contains an enormous number of Buddhist temples of various sizes and styles of architecture, and the city as seen from the river is described by Mr. Boyle as "one of the grandest and most impressive sights he has ever seen." Lower down the Irrawaddy below Prome there is a cliff about 2 miles long and 300 ft. high, on the face of which are carved innumerable figures of Buddha ranged in tiers from the bottom to the top. He thinks that some of these figures cannot be less than 20 ft. high. Many of them are richly gilded, and the whole forms "a very brilliant and curious sight." We reproduce an illustration showing the great recumbent figure of Buddha, in the province of Pegu, of which Mr. Boyle reports that "it is said to measure about 270 ft. in length by 70 ft. at the shoulder." In a paper read lately before the Anthropological Institute (see *Nature*, November 10, p. 46) Major R. C. Temple gives the length as 181 ft. and the height at the shoulder as 46 ft. This remarkable monument is built of brick, and Major Temple speaks of it as "well proportioned throughout." It is supposed to have been produced in the fifteenth century. It was hidden from view by jungle until 1881, when it was accidentally discovered by a railway contractor.—*Nature.*

[Continued from SUPPLEMENT, No. 889, p. 14207.]

THE WORLD'S COLUMBIAN EXPOSITION OF 1893.*

By JAMES DREDGE, Member of the Royal British Commission.

22. *The Fisheries Building.*—Although of smaller dimensions than any of the buildings facing on the great avenue, the Fisheries Hall is of very considerable proportions; and, while it does not compare in architectural magnificence with any of those great structures, the building will, doubtless, be one of the most attractive on the grounds. Considerable wealth and freedom of design are being lavished on the moulded decorations of capitals, cornices and panels, the treatment being highly original, wholly unconventional, and subordinated in all cases to the special purposes for which the building is devoted. The hall is rectangular, with two circular wings detached, except for a covered arcade. The main building is 364 ft. 8 in. in length and 161 ft. 5 in. wide, with central projecting vestibules that increase the extreme width to about 200 ft. Each vestibule is flanked by a circular tower 23 ft. in diameter and 61 ft. high. Winding stairs in these towers give access to galleries beneath the pointed roof. The vestibule between each pair of towers is 80 ft. wide, and its axis corresponds with that of the central dome, that forms one of the chief features of the building. This dome is 80 ft. in diameter, and 152 ft. 6 in. in height to the top of the lantern. The dome is 12-sided, and is framed on the square intersection of the 80 ft. aisle and transverse gallery. At each corner is a small tower, and the dome is supported on a series of columns. The building is covered with a central roof about 70 ft. high, and two half spans surrounding it of 37 ft.; the vertical walls between the top of these latter and the springing of the main roof are filled with windows. Most of the framing in this building is of timber or of wood and iron; the trusses are placed, generally, 20 ft. apart, and a gallery 24 ft. above the ground runs round the building. A second gallery, reached by two spiral staircases, runs around the dome, about 70 ft. from the ground. Besides the main structure, the Fisheries Building is completed by two circular annexes, placed symmetrically on each side, and connected to the hall by covered ways. These annexes are exactly similar in design, and help greatly to increase the pleasing and bold architectural effect of the whole structure. They are 123 ft. 6 in. in diameter and 70 ft. to the apex of the roof, which is surmounted by a flagstaff 28 ft. high. Each annex is composed of a central rotunda, 59 ft. 4 in. in diameter, surrounded by a lower roof 37 ft. 1 in. wide. The rotunda is carried upon 16 columns, extended from the ground to the springing of the dome, a height of nearly 40 ft. The principals, resting on these columns, and converging to a central casting, are of a very simple form of construction. The tiled roof covering is secured direct to a series of wooden purlins, fastened to the rafters by angle brackets. The roof is also carried on 16 trusses, symmetrical with those of the rotunda. The height from the floor line to the roof springing is 20 ft. 6 in. The framing of the rotunda roof is concealed by a decorated ceiling of fibrous plaster; and, indeed, the whole skeleton is hidden in the same way, the steel stanchions being converted into highly decorated columns, supporting a wall with arched openings, all hidden by lathing and staff. Above this wall is a circle of smaller columns, that appear to carry the roof. In this way the whole structural work is concealed. The arched spaces between the columns are filled in with stained glass above and clear glass below, for the tanks of the aquarium, and the surrounding gallery is treated in a similar way. Tanks surround the rotunda and the encircling space, a broad path being provided in the latter; the center of the rotunda is occupied by a fountain. The internal arrangements of the other annex, which will probably be devoted to angling exhibits, will be somewhat different, but the structural details are similar.

23. *The Horticultural Building.*—The ground occupied by the Horticultural Building is nearly six acres. Its design is admirable, and on a scale harmonizing with the rest of the exhibition. The great constructive feature is the central dome, 180 ft. in diameter and about 140 ft. in height. This dome occupies the center, and is surrounded by a square court, roofed and about 30 ft. in height. The main entrance to the building is in the center of this court, and on each side within it is a wide circular staircase, lighted from a small dome that forms a conspicuous feature in the design. To the right and left of the central court run two galleries; one in the front is 69 ft. wide and 272 ft. in length; at the rear is a second gallery, which passes behind, but adjoins the central court; it is about 750 ft. long and 50 ft. wide. The latter gallery will thus form a continuous series of glass houses, maintained at different temperatures for varying floricultural exhibits. A clear space, 89 ft. wide and 272 ft. long, separates the front and rear galleries on each side of the dome, and forms two large open courts that will be utilized for horticultural displays. Each court is inclosed at the outer end by a spacious wing 118 ft. wide and 250 ft. long. Thus the whole building consists of the central dome and its surrounding covered court; of two spacious end wings, connected with the central court by a gallery in front and one at the rear, these galleries being spaced far enough apart to inclose two extensive open courts. A few words may be added about the constructive features. The dome is carried by a number of curved ribs, built of steel of very light dimensions, and of the same general character as has been already referred to. The foundations are of timber, similar to those of which a type has been already described. The ribs supporting the dome are not curved from the floor line, but rise vertically, like a great circle of stanchions within the inclosing court, as far as the level of the gallery running round the dome, 22 ft. above the floor; above this the curving is commenced, and the ribs, converging almost in a semicircle, meet overhead against a ring to which they are riveted. The height of this ring above the floor is about 120 ft. There are 20 of these great ribs in all; they are connected together in various ways, besides the central ring at the top. At a height of 22 ft. above the floor, and again at 37 ft., a series of light girders connects each rib around the circle. Between the upper row of these girders and the crown of the dome, the rings or purlins, made of angle iron and lattice like the ribs, only lighter and not so deep, are riveted to the ribs. Thus the whole surface of the dome is divided into panels, and every panel is braced by diagonal tie rods. Midway between each pair of ribs, a secondary rafter, curved to the same form as the ribs, is riveted to the purlin, thus further dividing the panels and affording means for attaching the minor framing and sash bars. The front gallery is wholly of wood and glass. The roof trusses are peculiar in consisting of 18 boards, 12 in. wide by 1 in. thick, bent into a circular form and lightly braced. The span is 69 ft. and the height to center is 38 ft. These trusses are placed about 25 ft. apart. The rear gallery, which is much narrower than the front one, is covered with a light pitched roof, and the construction of the wings calls for no particular notice. These wings are not intended for the display of plants in growth so much as for horticultural and other exhibitions. Glass does not, therefore, enter so largely into the construction of these wings as in those of the other parts of the building.

24. *Fine Art Galleries.*—Great care has been exercised in the design and construction of the fine art galleries, which consist of one main building and two isolated annexes, for all of which the Ionic order of architecture has been selected. The plan of the main building is cruciform, with large courts at the four angles of the cross. Each arm of the cross, constituting a main aisle and a shorter transept, terminates in a great portico approached from without by a stairway, 60 ft. wide at the eastern and western ends and nearly 80 ft. wide at the northern and southern entrances; the height of the main floor above the ground is about 9 ft. The central aisle and transept are each 100 ft. in width, and are covered with pitched roofs, the construction of which resembles very closely those over the Galeries Rapp and Desaix of the Paris Exhibition of 1889; that is to say, the roof principals are supported at the ends by columns about 65 ft. high, and from these columns to the adjoining wall, a distance of about 20 ft., inclined struts are introduced, forming a continuation of the principal, and so preserving an unbroken angle for the roof. The space formed by the intersection by the aisle and transept is occupied by a rotunda, carried on masonry piers; the span of the dome covering the rotunda is 72 ft. This rotunda is entered through four openings 38 ft. wide, and axial with the aisle and transept. Above the springing of the roof over these central galleries the masonry is carried with a vertical face on each of the four sides, and against these faces the gallery roofs terminate, the dome springing above their level. The lengths of the aisle and transept are respectively 500 ft. and 320 ft., exclusive of the porticoes. Space is thus obtained outside the aisle and the transept for four external courts 200 ft. long and 100 ft. wide; around the two outer sides of these galleries runs an open colonnade that forms one of the principal architectural features of the building. Each of the four courts is divided into eight galleries and a corner pavilion, and numerous stairways are provided for giving access to the upper courts and galleries that extend around the aisle, transept, and rotunda. Although the external architectural effects are produced by timber

* This paper (lately read in abstract before the Society of Arts, London) was illustrated by a large number of lantern slides, most of which were prepared from photographs kindly supplied by Mr. C. D. Arnold, official photographer of the exhibition. From the *Journal* of the Society.

framing and fibrous plaster, the structure is wholly of brick, stone, and iron, and the columns rest on concrete foundations.

25. Professor Halsey C. Ives, the chief of the Department of Fine Arts, has furnished some very interesting statistics connected with that part of the exhibition in which he is specially interested, and in which the curious exception exists that the United States occupies only about one-sixth of the total hanging space within the Fine Art Building and its annexes. It is claimed by Mr. Ives that the collections in the Art Department will be as large and varied and of higher merit than have ever before been collected in America, or perhaps in any other country. In all, the applications for space from foreign governments amounted to 284,000 square feet. As the total amount of hanging space in the whole of the Art Buildings is only 196,400 ft., and as the American section required 34,600 ft. for its own artists, it followed that there were less than 162,000 ft. to satisfy the demands of foreign exhibitors. This somewhat contracted space has been divided between France, Germany, Great Britain, Austria, Spain, Italy, Belgium, Holland, Norway, Sweden, Denmark, Russia, Canada, Mexico, and Japan. Of course in no case could the demands made be complied with, and in one respect this, perhaps, is fortunate, as it is probable that a more careful selection will be made among the works of art submitted for exhibition than would be the case had there been no restrictions with regard to space. France has received the largest allotment, and Mexico the smallest, the figures being 29,200 square feet and 1,500 ft. respectively. France, indeed, seems desirous of making an exceptionally good display, and this is not to be wondered at when the close sympathy existing between French and American artists is considered, as well as the fact that French pictures find so ready and profitable a market in the United States. The head of the French Art Department is M. Antonin Proust, and he states that the work of selecting pictures for exhibition is nearly completed. One special feature of the French court will be a retrospective gallery, and it may be mentioned, in passing, that this will be chiefly furnished from American private collections. The French government has also given permission for casts to be made of the historical monuments at the Trocadero, and these are nearly completed. As regards our own art section, which is presided over by Sir Frederick Leighton, it is sufficient to say that there is every reason to suppose it will be in all respects as satisfactory as that which gained so much distinction in the Paris Exhibition in 1889. Greece will send many pictures, but its chief exhibit will be 100 casts of classic sculptures, selected from the best examples in the possession of the government. In the United States section, American art is to be better represented than at any previous exhibition, and committees of American artists are now at work in New York, Philadelphia, Boston, Paris, London, Munich, Florence, and Rome, with the object of collecting suitable work from native artists residing abroad. These committees form bodies for preliminary selection, and the pictures they approve will be forwarded for exhibition subject to the assent of a national art committee sitting in Chicago. By this means it is expected that for the first time the exact standing of the United States in the art world will be clearly demonstrated. Another interesting feature of the American section will be the retrospective galleries, filled with pictures painted prior to 1876, the year of the Centennial Exhibition, which was probably the earliest date at which any important collection of works of American artists was made. It is of interest to note the fact that while the collections from foreign countries in the Art Building of the Centennial Exhibition were remarkable for their size and value, and far surpassed anything that had been previously seen in America, they occupied only 76,790 square feet. Next year, as has been already stated, foreign exhibitors will occupy nearly 162,000 square feet, or more than twice as much, and this amount falls short of the space required by 120,000 square feet.

26. *Government Building.*—The Government Building at the Columbian Exposition is a very elaborate and imposing structure. While assuming little actual responsibility, the United States government has so closely identified itself with the vast undertaking that the government exhibit will be fully worthy both of Washington and of Chicago. In my paper of a year ago I gave very full particulars of the exhibit of the Navy Department, which will be arranged within a full-sized model of an American line of battle ship constructed in the lake. This interesting model is now rapidly approaching completion.

The other government departments will find accommodation within and around the official building, which is 350 ft. wide and 420 ft. long. The dominating feature is a great central rotunda, covered with a dome 120 ft. in diameter, and rising to a height of 150 ft. Around the dome will be arranged the courts of the various departments—those of the War Department, the Treasury, Agriculture, the Post Office, and so forth. The exterior of this building will be of a highly elaborate character, the principal features being a magnificent central entrance and very ornate corner pavilions. But the chief beauty of the building is the central rotunda, which will be elaborately decorated from floor to lantern, and around which various galleries will run, to which the public will be admitted. This rotunda is framed with sixteen great vertical columns, rising to a height of 115 ft., at which level the dome commences, its framing being a curved continuation of the vertical stanchions. From the top of the dome rises a lantern about 50 ft. in height and 30 ft. in diameter; light will be thrown from this lantern and from the upper part of the dome through the stained glass of an inner ceiling, suspended at the height of 150 ft. above the floor. The exterior walls of the Government Building are framed in timber, but all the interior framework and roofs are of iron.

27. *Women's Building.*—A very full description of this building, and of the nature and scope of its contents, were given in my paper of last December, at which time the structure was practically complete. There is, therefore, no necessity for reverting to the subject, except to say that the American, as well as the foreign committees, composed entirely of ladies, are very energetically occupied with their responsible task.

28. *The Manufactures and Liberal Arts Building.*—The largest and most important building of the Columbian Exposition, that of the Industrial and Liberal Arts, remains to be described. It covers under its roof no less than 30½ acres, and the estimated cost was £200,000. The contents of the building will be very varied; they will include the exhibits grouped under department H (Manufactures), department L (Liberal Arts), and department M (Ethnology, Archæology, etc.) Department H comprises all branches of manufacture; department L includes education, literature, engineering, public works, music and the drama.

The plan of this great structure is rectangular; its vast area is inclosed on all four sides by courts in three spans, one covered by an arch 101 ft. wide, and on each side of it by a lean-to roof of about 50 ft. These galleries surround a great central court. In the earlier design of this building it was intended to preserve the greater part of this inner court as an open space, broken in the center by a dome-covered rotunda of nearly 400 ft. in width. But two reasons brought about a change in this plan. In the first place, it was evident eighteen months ago that this court would be needed for exhibits under cover; in the second, the whole scheme had so grown in the hands of the organizers that it was considered necessary to have one vast monumental building, the size of which should be greater than had ever before been attempted. The court inclosed within the outer galleries presented just the conditions for supplying these requirements, and it was therefore determined to cover it with one clear span of larger proportions than had been ever attempted before. Before proceeding to describe this, the most striking engineering work of the exhibition, a few words should be given about the general characteristics of the building. The leading exterior architectural features are those common to the other large buildings—arcades running round the structure, and contained within the narrow outer gallery before referred to; these arcades afford a spacious and convenient promenade on the ground floor, and in an admirable exterior gallery above. In the design of such vast buildings as these, especially where the plan is necessarily of quite an elementary character, it is extremely difficult to judge of the architectural effect from drawings. On paper, the repetition of a long series of arches becomes monotonous, and the more striking features, that may prove admirable in execution on so great a scale, are apt to leave a disappointing impression when drawn on paper. This impression may possibly be produced by an inspection of the designs, especially when taken in connection with the plain pitched roofs over the arcades and the enormous domed structure above. In execution, however, the appearance will be wholly different, and it is only necessary to recall the contrast that existed between the plan of the great machinery hall of the Paris Exposition of 1889 and the actual structure to realize that the Industrial Hall at Jackson Park will not suffer by comparison with its smaller prototype on the Champ de Mars. An inevitable penalty, however, must be paid for these heroic dimensions; every one will remember how, in 1889, the span and height of the machinery hall dwarfed the exhibits, and this will be still more apparent where dimensions are far larger, and the show cases of the industrial exhibitor will usually be of less imposing appearance than the contents of a machinery hall.

The Manufacturing and Liberal Arts Building consists of a great central hall 1,268 ft. in length and 386 ft. in clear span; the height of this hall from the floor to the underside of the roof girders is 206 ft. 4 in. clear and to the top of the ventilating lantern 245 ft. 6 in. This vast roof is supported on 18 main ribs, spaced 50 ft. apart; these provide for 850 ft. of the 1,268 ft. constituting the hall; the remaining 209 ft. at each end are filled in with a gigantic gable, framed upon two long trusses starting from the extreme corners of the structure, and meeting at the ridge; the curves of these trusses are, of course, projected to suit the sweep of the roof, and to them are framed partial ribs finishing against the gable trusses on each side and at the ends. As nearly as possible the spacing of 50 ft. is maintained for all these trusses. The great roof ribs are hinged at the bedplates and the apex; the intrados of the truss is curved almost from the ground; the outside is vertical for about 100 ft., and then it sweeps upward to the ridge with a flat curve. The first four bays are braced diagonally, and after that alternate bays, formed by two principals, are braced together. As may be supposed, the roof purlins are formidable structures, and three tiers of longitudinal girders connect the trusses in the 100 ft. space formed by their vertical ribs; the building is surmounted by a high and wide lantern; the unglazed part of the roof is close boarded, and the exterior covering is sheet iron.

As stated above, this great hall is surrounded by what in comparison are quite insignificant structures, but which, nevertheless, are of considerable dimensions. They are provided with galleries that in the inner span are extended inside the great hall between the trusses; although these galleries look very low, they are more than 20 ft. above the ground, and they are sufficiently extensive to give a large additional area for exhibition purposes. These galleries are connected across the center span of the surrounding courts by broad and frequent gangways, which also afford considerable floor space.

29. The time available between the inception and the opening of an exhibition is so short that manufacturers have always to pay great attention to the question of erecting the structures in order to complete the work in the period allowed. It must be remembered, too, that, although only required for a short period, the construction must be as strong as if the building were to be permanent. The Manufactures and Liberal Arts Building is an extraordinary illustration of rapid construction. The Edge Moor Bridge Works signed the contract on December 24, 1891, and undertook to complete the work before August 15, 1892, so that they had only seven and a half months for this immense undertaking. The method of erecting the roof can be explained without the aid of diagrams. As already stated, each span is pivoted at three points—at the springings and at the apex—to simplify the calculation of the strains, and in this respect the designers followed the example set at Paris. In other points there is a great divergence between the two designs, the Paris arch being a plate girder with a spandril filling, instead of a light braced structure. The systems of erection were also dissimilar, as might have been expected. In the matter of dealing with large pieces of framed work, the Americans have little to learn from the rest of the world, and this seems clearly demonstrated by the fact that they reduced the time taken in erecting the roof to one half of what was required in France, and which appeared at the time wonderfully rapid. The general plan which was adopted was as follows: Each half of each rib was built in two sections; from the ground to a point about 100 ft. above the ground—that is, as far as the vertical back of the rib extends—was erected in place, and from that point to the apex, the upper part was put together on a platform erected on a movable stage, and was afterward hoisted into position and connected to its fellow. The movable staging, or traveler, was constructed of three towers braced together so as to form one structure. The two side towers were each 134 ft. high, and 50 ft. wide from center to center of the timbers, measured in the longitudinal direction of the building.

The central tower was in two stories; the lower part was 134 ft. high, like those of the side, but it was extended to a width of 80 ft. by raking side struts. The summit of the second story was 222 ft. 6 in. high, its upper platform being capable of being lowered when the staging was to be moved. The whole structure was mounted on 28 heavy wheels, 20 in. in diameter, running on eight lines of rails, carried on a timber foundation laid on the floor; its weight was estimated at 350 tons. As the width of the traveler was the same as the distance between the ribs, it became possible to erect two of these latter simultaneously. To allow of its being traversed as the work progressed, its greatest dimensions were somewhat less than those of the contour of the arch, except in the case of the upper tower, which, as said above, could be lowered. This necessitated the use of very long crane arms for assisting in the erection of the upright part of the arch. Four cranes 62 ft. in length projected from each end of the traveler and these were operated by two winches of 24 horse power each with six independent drums.

30. The iron and other materials for erection were brought into the building by temporary tracks, laid on the floor parallel to the staging, and were lifted by the cranes and built into place, the side pieces of the arch being, meanwhile, steadied by struts from the stages and the ground. On reaching a point about 100 ft. from the ground, another system of construction was adopted. The part already completed was firmly connected to the scaffolding by means of adjustable loop rods and hydraulic jacks. On the higher story of the central tower were four cranes, each 36 ft. long, worked by a twenty-four horse power engine, with six winding drums at the ground level. These cranes were employed to lift the material for the upper part of the arch, and to lay it on trucks running on rails upon the upper platform of the stages. From these it was taken by two smaller travelers running on the upper platform, and laid on a curved centering built on the platform, and corresponding to the upper part of the arch. The upper half of the rib was connected to the lower half by a pin, that formed a pivot or hinge. Owing to the comparatively light character of the upper parts of the arch, they were rapidly completed. Two adjoining half arches were then connected together by the purlins and bracing rods, and hoisted into position from the central tower. As the half arches overlapped on the false work, one had to be lifted before the other was completed. When this latter came to be raised, it would have fouled its companion just as it was attaining its highest position, and to prevent this, the hinge pins were forced apart from one another by the hydraulic jacks through an additional three feet. This allowed ample clearance to get the half arches into position, and then to allow them to come together and meet on the connecting pin at the apex. The jacks were then slacked back until the joints closed and were secured by bolts. The pair of arches then stood firm and safe. Each pair, when completed, weighed about 430 tons, while the weight of each piece lifted from the central tower was 32 tons, except in the case of the end arches, which weighed 40 tons.

When one bay was completed, the traveler was moved forward for erecting the next pair. This was done by means of three twenty-four horse power winches hauling on the staging. This operation occupied from forty-five to sixty minutes, while lowering and raising the tower, and the miscellaneous work of getting into position, lengthened the time to half a day. The lantern frames, jack rafters, etc., were put in place subsequently by small travelers running on the purlins. It will be readily conceived that the method of working, which was devised by Mr. S. P. Mitchell, assistant manager of the Edge Moor Bridge Works, enabled the erection to be carried out very rapidly, since two arches were always in hand at one time. The first pair of ribs occupied nine days of ten hours; the second pair, eight days, and the fourth pair, five days.

31. It will be interesting to compare these times with those occupied in the erection of the spans in the machinery hall at Paris. The work was there divided between the Fives-Lille Company and MM. Cail & Co. The former put the ironwork together on the ground for each span in four separate pieces, and then raised them into place. The scaffolding consisted of a tall gantry, as high as the middle of the roof, and of two side platforms. These three structures were independent of each other, and ran on rails. The central tower was 72 ft. long, 62 ft. wide, and 144 ft. high. The width of one bay being 70 ft. 6 in., the gantry was wide enough to include two consecutive girders, while its upper part was formed to the same contour as the underside of the roof. The side scaffolds were also formed to the same contour as the roof, and covered with planking. A considerable part of the arch was built on the ground. Its lower end was then engaged with the bottom pivot, and it was raised into position about that center. The remaining portion of the half span was also built on the ground, and then lifted bodily until one end rested over the central staging and the other over one of the side stagings. The pieces were then riveted together. The first bay was completed in twenty-three days, the second in sixteen days, the third in twelve days, and the rest in ten days each. The Cail Company followed quite a different plan. It consisted in constructing a narrow scaffolding, the top of which was the same form as the inner side of the arch. Portions of the girder, not exceeding three tons in weight, were rivet-

ed upon the ground, and then raised and put together on the staging. The first girder and bay were completed on May 24, 1888, the second girder and bay were finished in thirteen days, as was also the third; the fourth and fifth were completed in twelve days; the remainder took ten days each on the average. It will be seen that the work at Chicago has been done with unprecedented rapidity. In seven and one-half months detailed drawings were prepared; the steel and iron work constructed and transported nearly 1,000 miles; and about 7,000 tons erected.

32. From the foregoing description some idea will be gained of the internal appearance of this vast building. The side galleries that surround it, extensive though they are, are of necessity dwarfed into comparative insignificance by the large dimensions of the Central Hall, and there is little doubt that the imposing appearance of the exhibits will also suffer from the same cause. And yet, as was the case with the machinery hall at the Paris Exhibition of 1889, it will be difficult for the visitor to estimate, by the sense of sight, the size of the building. It will be only by the experience of fatigue that he will understand its size, after he has devoted many hours or days to the examination of its contents. The main passages for circulation will be a path 50 ft. wide, running from end to end down the center of the building, and called Columbian Avenue, while another of similar width crosses it at right angles on the shorter axis. The intersection of these avenues will form a central open space, upon which will front the four courts of the most important nations exhibiting—those of the United States, Great Britain, France, and Germany. It does not come within the scope of the present paper to attempt any description of the probable contents of this building. Nearly the whole of the ground floor will be devoted to manufactures, a comprehensive term that includes the product of innumerable industries. It will be in this building that English visitors interested in, or fearful of, the industrial progress of the United States will be able to form a fairly accurate estimate of the capacity for production, and the quantity of the output, of the country we are beginning to regard as our chief competitor in the near future. No similar opportunity has been offered since 1876 at the Centennial Exhibition, and that is now almost a prehistoric period in the history of commerce. The displays that America has made at subsequent foreign exhibitions have afforded no measure of her power, and it is for this reason that the American section of the Manufactures Building will prove of the highest interest to ourselves.

33. Another collection of the highest importance, though not so directly bearing on financial interest, is that which gives its second name of Liberal Arts to the building. Judging from what Dr. Peabody, the chief of this department, has written at a very recent date, commercial interests have been too great for those of liberal arts, which have suffered accordingly from want of space. It was at first intended that a large part of the space should be devoted to the latter department, and when it was found that the demands of manufacturers were so great as to fill a building four times as large, there was an effort made to have a separate hall erected for the liberal arts. This was found, however, to be impracticable, and by patient and consistent compression, the liberal arts will be accommodated under the same roof as the manufactures. On this subject Dr. Peabody writes: "The interests confided to the Liberal Arts Department are those of education, science, literature, and the whole circle of the arts. For six months the decision wavered in the balance whether this department should have provision for its needs proportioned to that granted to the other departments of the exposition. Under great pressure, three-eighths of the space once accorded to it have been assigned to others, and the persistent efforts which its friends have so earnestly made have been not to add to its facilities, but to in some measure restore those which had been taken away." It is yet hoped that this pressure may be reduced by the erection of an additional building for educational exhibits, but the prospects of this extra accommodation are very slender. A few figures furnished by Dr. Peabody will show how large and important a section that of education will be if sufficient space can be provided. With regard to foreign countries, France and Germany ask for 60,000 square ft. of space, and the British Liberal Arts section should occupy the same amount; the Roman Catholic Church applies for 60,000 square ft. for its educational exhibits; and in the United States more than ten times that area, or 650,000 ft., are asked for by 1,100 different applicants, in forty-one States and Territories. Most of these applicants are the leading universities, colleges, and schools of America, and many of them propose to send very elaborate and complete exhibits, illustrating their system of general and technical training. Collective exhibits are also being arranged by commercial colleges, manual training schools, art schools, educational establishments for the mentally and physically afflicted, schools for Indians, etc. It is intended, if the scheme is found practicable, to show a number of different classes in active operation, so that the various systems of training may be properly illustrated. Altogether about 325,000 square ft. of space will be required for the American group of educational exhibits, which will represent the training of 14,000,000 American children and students by 500,000 professors and teachers. The various colleges and schools are spending at least £100,000 in preparing for this exhibit. Of other branches of the liberal arts, the space demanded for hygiene and charitable institutions is 30,000 square ft.; for medicine and surgery, 20,000; for books and literature, 35,000; for physical apparatus, 25,000; for photography, 10,000; for engineering and architecture, 10,000; for social and religious organizations, 10,000; and for musical instruments, 100,000 square ft. This last group, it is intended, will be of great interest and importance. It will include an historical loan collection, and is under the special charge of the Bureau of Music, which will control the entire musical arrangements for the exposition. The group will be exhibited on the ground floor of the Manufactures Building, a location having been assigned to it near the Music and Concert Hall. The other objects of the Liberal Arts Department, except education, will be displayed in the spacious galleries on one side and part of each end of the building. Space for these groups will be thus provided; it is only the educational exhibits which at present are in danger, and which appear certainly likely to suffer almost to extinction if the demand for a special building cannot be complied with.

34. *State Buildings.*—The various States and Territories have contributed collectively large sums for the erection of buildings, and for the exhibits which will be placed within them. These buildings occupy a large area on the north side of Jackson Park; the principal of them is appropriately the building of the State of Illinois, which will cost £60,000, and which is 450 ft. long and 160 ft. wide. In the center of this building there will be a lofty rotunda covered by a dome, which will be a conspicuous object throughout the grounds. Around it will be distributed the offices and headquarters of the governor and other State officials, and in a fireproof annex will be displayed the various relics and trophies belonging to the State. It will contain a large collection of objects illustrating the natural resources of Illinois, and the various State departments will have special allotments.

The more important of these will refer to the common and higher schools, charitable institutions, and agricultural products; the geology, botany, and zoology of the State; architectural drawings of every public building in Illinois, and a large number of other objects. It would occupy too much space to attempt a description of the numerous State buildings; some few particulars may, however, be given. The California Building, with its exhibits, will cost £15,000. It will be in part the reproduction of one of the old Spanish missions, the remains of which are plentiful in California, and which were founded 120 years ago by the Roman Catholic priest, Junipero Serra, who for many years devoted his life to missionary work upon the Pacific coast. The building of Colorado, which is nearly finished, is an elaborate structure of native granite and marble. The State of Connecticut raised £10,000 by private subscription for its building, which is nearly finished. The building of the State of Florida, extremely primitive in appearance, is of great historical interest. It is the reproduction of the original Fort of St. Augustine, which, with the town of that name, was founded by the Spanish in 1665. Since then it has been the scene of many a bitter fight between the Colonial troops and the Spanish, prior to the cession of Florida to Great Britain in 1763, when it was exchanged for the island of Cuba. The State of Georgia raised £20.000 by private subscription, but its building has not yet been commenced. That of Indiana is constructed wholly of native material, but will cost only £5,000. Iowa is devoting £10,000 to its building, which is well advanced. Kansas, although it obtained £20,000 by private subscription, is spending only £4,000 upon its pavilion, which is nearly finished. The State of Kentucky will have a building costing £20,000; and the almost completed pavilion of Maryland, which is built of granite, will cost £7,000. The State of Michigan is spending £10,000 upon its buildings, which will be constructed wholly of native material. That of Missouri, although one of the smallest of the series, is to cost £10,000. Montana has a fund of £20,000 for its building and exhibits. Nebraska only collected £10,000 and New Hampshire £5,000. The government of New Jersey appropriated £14,000, and will have a fine pavilion, which is well advanced. North Carolina and Dakota each subscribed £5,000. The States of Ohio and Oregon have funds of £20,000 at their disposal, and their pavilions will make a very much finer appearance than that of Rhode Island, whose pavilion will only cost £600. South Dakota raised £16,000 by public subscriptions, and its extensive building, which will be the reproduction of an old-fashioned French farmhouse, will be very striking and picturesque. Vermont only secured an appropriation of £5,000, so that its building will be a simple and modest one. The State of Virginia is spending twice that amount for its pavilion, and Washington is devoting about the same amount to this purpose. The most original of all the State buildings will be that of Utah, which will be constructed of salt, and which will cost £10,000. Wyoming will restrict itself to a club house of very modest dimensions, costing £4,000. The building of New Mexico will cost £15,000. The pavilion of Louisiana will represent a typical Southern house, and will cost, with its exhibits, £10,000. The State of Maine will be represented by a sufficiently spacious club house, which, as it is constructed of native granite conveyed for nearly 1,000 miles, appears cheap at £2,000. Massachusetts spends four times that amount in the reproduction of a famous old Boston house, which was erected in 1737. The pavilion of New York State is also historical, as it is the reproduction of the famous building once occupied by Van Rensselaer, who figured prominently in the Dutch period of New York's history. New York State made an appropriation of £60,000, and the appropriation of Pennsylvania was for the same amount. The Pennsylvania building will, after that of Illinois, be probably the most important in the grounds. It will occupy in all the space of 18,000 square feet, and will reproduce the general features of Independence Hall, of Philadelphia, especially the historic clock tower, and the bell which tolled the knell of British rule in America, and rang in the birth of the new republic. This bell will be hung in the clock tower of the Pennsylvania building at Chicago.

From the foregoing summary it will be seen that these buildings, which will in all cost about £300,000, will make a beautiful and varied show. So also, at a less extent, will the pavilions of foreign nations. That of this country, in which we are most interested, will doubtless be worthy of the beautiful site allotted to it on the shore of Lake Michigan.

35. *Previous Exhibitions.*—It may be of interest to make a few general comparisons between the forthcoming Columbian Exposition and its principal predecessors. Beginning with the first great World's Fair that was held in Hyde Park in 1851, and was the forerunner of the long series which at short intervals has delighted the public and harassed the manufacturer, we find that it was held in a building 1,851 ft. in length and 450 ft. in width. One of the buildings in Jackson Park, that of the Manufactures and Liberal Arts, is 1,687 ft. in length and 787 ft. wide; this building alone could have contained the exhibition of 1851 within its walls; but this early exhibition was not only the most marvelous, but also the most successful that has ever been held, for it closed its doors with a net profit of £150,000—a result which has never been reached at any subsequent exhibition. It was remarkable also for the large number of exhibitors crowded within the narrow space, the number falling only just short of 14,000, of which, astonishing to relate of that far-off time, more than half came from our colonies.

In 1853 the first World's Fair held in the United States was opened in New York. It covered an area of 263,000 square feet, and it contained 4,100 exhibitors, more than half of whom were foreigners. The total expenses amounted to only $640,000, and the receipts to $340,000, so that there was a loss upon the enterprise of £60,000.

In 1855, the first International Exhibition was held in Paris under the auspices of the French government. It was for this exhibition that the Palais de l'Industrie was erected, and which alone remains of the numerous additional buildings and annexes, which together covered an area of 1,886,000 square feet. There were in all nearly 24.000 exhibitors, of whom 144 were from the United States. The total number of visitors to this exhibition was 5,162,000, and the largest number of visitors on any one day was 121,000. Passing over the smaller exhibitions of 1854 in Melbourne, of 1857 in Brussels, and that at Lausanne in 1858, at Turin 1856, at Hanover in 1859, we come to the second Great Exhibition held in London in 1862. Its main buildings covered 17 acres, or less than the Machinery Hall at Chicago. The total cost of the buildings was £320,300, and the entire outlay was about £460,300, so that the loss on the undertaking amounted to £140,000. The visitors to this exhibition were 6,210,000 and the largest attendance in any one day was almost exactly one-half that at Paris in 1855.

The second Great Exhibition in Paris was held in 1867, the principal building of which covered 11 acres; the Champ de Mars was, however, crowded with a large number of annexes and small structures. There were no less than 52,200 exhibitors, and a total of 10,200,000 visitors was recorded. The gross receipts amounted to about £400,000. The Great Exhibition of Vienna, held in 1873, was rendered an unfortunate failure by the visitation of cholera in the city that year, and which was the cause of the small number of visitors which attended it. The municipal guarantee loan and the government loan together produced the capital of £900,000, and the buildings were the most extensive and elaborate that had been built for such a purpose up to that time. The main building was no less than 2,953 ft. in length; it was intersected by sixteen transepts, each 573 ft. long, and in the center of the building there was a gigantic dome 354 ft. long. Agricultural exhibits were held in a separate building covering 6 acres, and the Machinery Hall occupied an area of 10 acres; the Art Building, a very beautiful and elaborate structure, was 600 ft. long and 100 ft. wide. The Centennial Exhibition, held in Philadelphia in 1876, was intended originally to be only a national exhibition; at the almost unanimous desire of European countries it was converted into a World's Fair and largely extended. The necessary funds were raised by public subscriptions all over the United States; by a loan from Congress of $1,500,000, a present by the city of Philadelphia of $1,000,000, and another gift by the State of Pennsylvania of $1,500,000. The exhibition was held in Fairmount Park; it occupied 285 acres of ground; the buildings were numerous and some of them beautiful, especially the Art Gallery, which remains as one of the monuments of Philadelphia to-day. There were 30,864 American exhibitors; Great Britain and the Colonies contributed 3,584 exhibitors, and Spain was largely represented with 3,822. Altogether 32 foreign nations took part in this exhibition, which was visited by 9,911,000 people; the greatest number of visitors in any single day was 275,000.

The Paris Exhibition of 1878 was held in the Champ de Mars and in the Trocadero; the main buildings covered 54 acres, but, of course, this was largely supplemented by a great number of annexes and special buildings. There were 52,835 exhibitors, of whom 25,872 were French, 3,184 British and Colonial, and 1,203 American; the total number of visitors was over 16,000,000, and the receipts were about £500,000. As the exhibition cost was nearly 2¼ millions, there was a loss on the undertaking of £1,716,000, but of course the city of Paris benefited largely by the immense crowds that flocked to the city during the year. The Great Paris Exhibition of 1889 appeared to every one to have reached the highest point of which exhibition development was capable. The amount expended on the buildings and grounds was considerably over one million sterling; the number of visitors exceeded vastly anything that had been obtained at any previous exhibition, and attained the stupendous figure of nearly thirty millions. This was only reached by the ingenious operation of issuing government lottery bonds, to which entrance coupons were attached, to the public in such large numbers that the value of the coupons was reduced, during some portion of the exhibition, to one-fourth of their value.

The area of the Columbian Exhibition ground is 666 acres; this is crowded with buildings to the extent of over 200 acres, the cost of which considerably exceeds two millions sterling, while the total expense is estimated at between four and five millions. It is too early to form any estimate of the number of exhibitors who will find space, and it would be a waste of time to speculate as to the probable number of people who will visit the exhibition next year. It is hoped, of course, that this will exceed the total made in Paris in 1889, but it appears hardly likely that such a result will be achieved, considering the high price charged for admission and the restricted privileges that will be accorded on Sunday; even if visitors are admitted at all on that day. In any case it is almost too much to hope that the Columbian Exposition will prove a direct financial success, but that is a matter of infinitely small importance compared with the enormous pre-eminence and indirect benefits that will accrue from it to the city of Chicago and to the United States.

36. *Conclusion.*—This is not the occasion, nor am I sufficiently acquainted with the subject, to dwell on the great and unexpected political event which on the 9th of last month took the whole of America and Europe by surprise. I think the annals of United States history do not furnish a precedent for such an overwhelming expression of opinion of the national will. As to the cause which brought a party into power whose popular motto is "Protection for revenue

only," I know little or nothing. We are told by the newspaper organs of the triumphant party that it is a protest by the most intelligent voters in the world against an exaggerated system of protection, which created monopolies and benefited the capitalist at the expense of the working classes. On the other hand, Republicans attribute their defeat to one of those inexplicable attacks of mental alienation that occasionally sweep over a nation at critical periods. I suppose that the general feeling in Europe is one of satisfaction at the prospect of a modification involving great reductions in the present tariff, which has already borne hardly on many of our industries. And it is probable that if this presidential election, with its strange result, had taken place a year ago, the applications for space at the Columbian Exposition, from our manufacturers and from those of the rest of Europe, would have been far more numerous. As it is, those who were enterprising enough to devote time, money and trouble to help swell the great display at Jackson Park will feel more hopeful of the result of their venture; and at present there is a general belief that the time is not far distant when the United States shall again prove to be an almost open market. It is certain that the Democratic triumph, generally construed as a popular protest against extreme protection, has met with hearty, though perhaps not disinterested, sympathy in this country, and that much of the indifference, and even hostility, displayed against the Chicago World's Fair will be exchanged for active interest and sympathy. There cannot be more foreign exhibitors, for there is no more space to be allotted, but if all be well there will certainly be more visitors from Europe.

I think it will be found, after the exhibition is over, that their American hosts have treated British exhibitors with more than usual courtesy and generosity at Jackson Park. The free permission to attach labels bearing sale prices at the place of manufacture is a proof of this. This was a privilege absolutely refused at the Centennial Exposition of 1876, when tariff laws were less oppressive and competition had scarcely begun. The value of this privilege is indeed very great, considering that the display of prices free of duty will carry a striking lesson to the minds of the masses eager for proofs to justify their recent political action. It will also prove of the greatest benefit to British exhibitors, because it will vastly increase the chances of transacting business with foreign buyers over the heavily handicapped American manufacturer.

It must be borne in mind that a great International Exhibition is not planned and brought into existence at a vast outlay for sentimental purposes. Still less is it held in any country for the benefit of foreign manufacturers. An exhibition cannot be international without the co-operation of foreign nations, but, setting aside its good effects as a popular educator, and the incalculable benefit of healthy but severe competition, the main object of the country holding it is, as far as possible, to increase its foreign trade at the expense of other countries. The ideal International Exhibition—no matter where it is held—would be one to which foreign nations would contribute in such a way as to add to its beauty, completeness and value without interfering with its anticipated commercial advantages. But, on the other hand, exhibitors will not incur all the expense and trouble of participation without the hope of profit, and without the prospect of maintaining their existing business and making new connections. On both sides these objects are wholly praiseworthy, and entirely antagonistic, and bearing in mind that one of the chief ambitions of the American nation is to extend their foreign trade, I think the grant of full privileges of pricing exhibits is a most generous concession to our exhibitors, and indicates clearly the good feeling that exists toward us.

I trust that the experience of a large number of Englishmen during the next year at Chicago will do much toward strengthening this good feeling, which can always exist even in the face of the fiercest competition, and that a year hence I may once more have the pleasure of addressing you on the subject of the exposition, and on some of the lessons which it has taught after it has become a thing of the past.

IMPROVED PARALLEL SLIDE VALVE.

THE valve presented in Figs. 1 and 2 is an improved construction of valve made by Messrs. J. Hopkinson & Co., engineers, Huddersfield, which has been extensively adopted for the regulation of water, steam and other fluids. The valve, it will be seen, gives a straight clear thoroughfare equal to the bore of the pipe. As a straight through-way valve the main feature is that the valve disks, B, are kept against their respective faces by a spring shown, so that, when sliding, any grit which may have accumulated on the seat is removed therefrom, and the disks have always a clean face, and consequently remain tight. Among the improvements in this valve is the arrangement of the screw, A, outside. This has been found desirable for use with high pressure steam, so that the wear on the screw may always be observed, and being removed from the action of the fluid the wear is very considerably reduced. The screw, it will be observed, works in a trunk spindle, C, which passes through the stuffing box at the upper part of the casing, and the gland of which is of a composite character. In this gland a conical bush of specially prepared packing is inserted, and by slightly pressing down the gland by means of the nuts it is caused to grip the spindle and forms a fluid-tight joint. Another feature is the method of inserting the gun-metal seats, D, on which the valve disks slide. Where gun-metal seats are forced into cast iron bodies it is a common occurrence for them to become loose. The reason for this is obvious. Cast iron and gun-metal have different coefficients of expansion, and consequently when heated to the same temperature, a great stress is brought on the gun-metal seating, owing to its having greater expansion than the cast iron body, consequently its structure becomes compressed, and when the valve is allowed to become cool the seats are found to be loose. In this valve the gun-metal facing is secured to a ring of cast iron by countersunk set screws shown. The iron ring is then forced by hydraulic pressure into the body, and, having the same coefficient of expansion, practically forms a homogeneous structure. The by-pass valve, E, is provided to place the main valves in equilibrium before being opened. This valve is integral with the spindle, so that the hand-wheel opens the by-pass, and also lifts the main valve. By this arrangement a separate by-pass and valve are dispensed with. The belt of the spindle is bored slightly larger than the portion of the valve it surrounds, so that, before it commences to raise the main valves, the by-pass valve is lifted from its facing and allows the steam to pass, thereby equalizing the pressure on both sides. This by-pass valve may also be used for heating up steam pipes before the main valve is fully opened.—*Industries.*

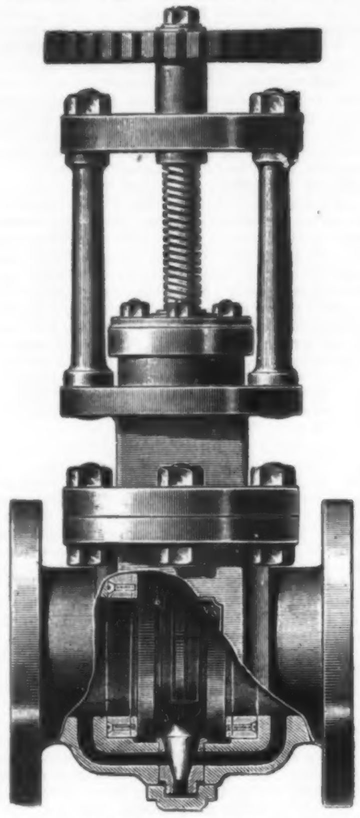


FIG. 1.—GENERAL VIEW OF VALVE PARTLY IN SECTION.

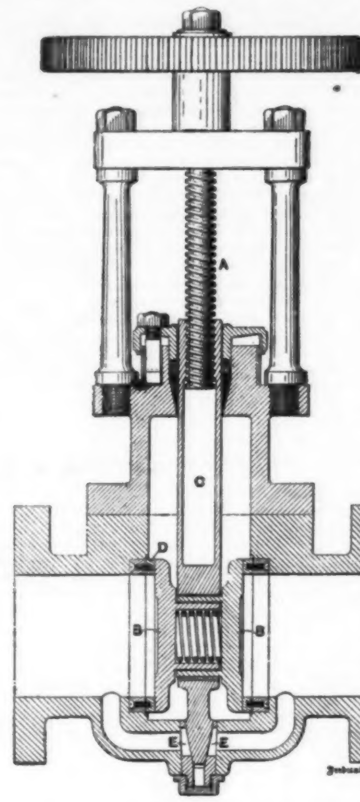


FIG. 2.—SECTIONAL ELEVATION OF VALVE.

IMPROVED PARALLEL SLIDE VALVE.

THE NEW CONNELLEY GAS MOTOR.

LAST year the North Chicago Street Railroad Company made some experiments with the Connelley gas motor. The result of those trials was so satisfactory that seven motor cars are now in process of construction here. The North Side company is making the bodies at their shops, at the corner of Fullerton avenue and Sheffield street. The Connolley Gas Motor Company, which owns the Illinois right to this invention, is making the motors at their factory on South Clinton street.

The fuel intended to be used is a mixture of 75 per cent. natural gas and 25 per cent. of gas made on the Pintsch system. This Pintsch gas is made from crude petroleum, and a contract has been let for a gas works to manufacture this gas at the corner of Larrabee street and Garfield avenue. The gas is to be carried in tanks on the car at a pressure of 200 lb. when first charged.

The pressure as it enters the motor is the usual gas pressure of only a few ounces. The object of the high initial tank pressure is of course to allow a greater volume of gas to be carried. It takes only a few seconds to fill the tanks. As equipped at present the cars carry four tanks, 20 inches in diameter and 48 inches high. When the tanks are filled with gas at a pressure of 200 lb., the car will run under ordinary conditions of load about 25 miles. If it is found desirable, tanks can be put around the top and sides of the car, giving the motor a supply for an all day's run.

The motor proper runs at 180 revolutions per minute and is rated at 10 horse power. It will be explained further on how this capacity is made sufficient for starting and ascending grades. The gas on entering the cylinder is exploded by the opening of a port leading to a small burner on one side of the cylinder. The time of explosion is regulated by a common eccentric on the engine shaft. An ordinary centrifugal governor such as is used on steam engines serves to regulate the supply of gas. An apparatus is attached to the motor for exhausting the cylinder, thereby allowing gas to be taken and ignited on every revolution, instead of every two revolutions, as in most gas engines. The water for cooling the cylinder is made to circulate through a tank traversed with flues to facilitate cooling. The next and most essential thing in the operation of the car is the friction drive. The motor is running all the time at a uniform rate of speed, whether backing, starting or going ahead. The friction drive is made by a hard steel wheel rolling against a soft steel plate on the engine axle. The engine axle is at right angles to the axle of the small wheel. This can best be seen by an inspection of the accompanying engraving which gives a view through the car door and shows the friction gear and end of the motor. When the car starts, the small wheel presses against the disk on the motor axle at a

FRICTION DRIVE—CONNELLEY GAS MOTOR.

point very near the center. As the car gains headway the motorman moves the small wheel so that it bears further out toward the circumference of the disk. In this way it is plain that the car can be made to run constantly at any speed without any waste of power. The disk is held to its work by a large ball bearing. The arrangement of the friction wheels is different from that used on the motors tried last year, and does away with a great deal of unnecessary strain. One great trouble with all forms of street car motors in use to-day is that the rate of working at the starting of the car is so slow that but a small fraction of their rated power can be used. With the motor running all the time, this difficulty is overcome, and the full power of the motor can be secured in starting. The power is transmitted to the wheels by chain and sprocket wheel. The cars are 11 feet bodies of the ordinary width. The weight complete is about four tons. It is intended to run a small dynamo in connection with a storage battery from the motor for the purpose of lighting the cars. The present motor is the result of long and careful experimenting and development, and the Connelley Company are confident they have now secured a practical, economical and reliable machine. The North Chicago Street Railroad entertain the same belief, and are proving their faith by the construction of a large number of these motors.—*Street Railway Review.*

HISTORY AND ADVANTAGES OF THE HARDIE COMPRESSED AIR LOCOMOTIVE FOR CITY RAILROADS.

THE publication of Gen. Haupt's article on compressed air motors, in the July issue of *The Street Railway Review*, in which reference was made to the experiments conducted under my supervision, as chief engineer of a company in New York City, a few years ago, has brought me a great deal of correspondence on the subject.

There are two questions which I have had to answer many times, viz.: "If the experiments proved that compressed air was in every way suitable, why was it abandoned?" and, "What is the cost of operating a railroad by compressed air?"

Gen. Haupt is of the opinion that a feeling among railroad men that possible heavy damages from frightening horses was the principal reason for their abandonment. True, this objection was made, but, as a matter of fact, horses paid no more attention to cars so operated than they do now to cable or electric cars; and it ought to have been as easy then as later to demonstrate that such fears were groundless. All sorts of objections were raised, and fears expressed, as to their practicability, just as there are with all new things. Some thought they could not be relied on to complete a trip without running short of power, others that they would prove too costly, a few thought their weight would injure the tracks, and one consulting engineer stated in a private report that "if the engineer in charge should resign, it would be difficult or impossible to secure another man with equal skill and knowledge to take his place."

Any motor which carries a limited supply of power will fail if taxed beyond its capacity. Steamships sometimes run short of coal at sea, and locomotives sometimes run short of coal or water, and have to be hauled to a supply station. Generally speaking, however, it is approximately known how far their supply will carry them, and the journeys undertaken are within the limit. Just so with compressed air. A motor which will take sufficient power for a ten mile trip is surely to be depended on for an eight mile trip.

As for injuring the track. It must be remembered that a horse car track is laid much heavier than necessary for the cars alone, on account of the ordinary heavy traffic of the street; so that much heavier cars are permissible; but, even should the track be more costly to maintain, it is then a question if the economy and other advantages of the system would warrant it, or the motors could be built of lighter construction, and smaller capacity, and recharge more frequently. Provision can be made for recharging anywhere en route, in as short a time as it takes to water horses. Those tested in New York City weighed about 11,000 lb. and could take a supply of compressed air for a ten mile trip. It was never found that they injured the track.

The proper way to have met all objections, however, was not by discussion and argument, but by a practical demonstration. Railroad men were not satisfied with a few exhibition trips of the motors, although as a general rule the performance was considered very satisfactory, so far as it went; but they all wanted to see a railroad operated exclusively, and successfully; and until then no railroad would adopt the system. As it required capital to do this, and as the motor company had practically none, the enterprise was never carried beyond the experimental stage. It is true that this company was capitalized at $1,000,000, but that needs explanation. Those who organized the company were men of no financial standing, and the stock was all issued to them, without payment or consideration, except the expenses of organization and a few preliminary tests. In order to evade the law, which required that the stock should be paid for at its full par value, a valuation of $1,000,000 was put upon some patents, which one of their number held in trust; and the stock was issued to him in consideration of said $1,000,000 worth of patents: said trustee then divided the stock, as previously understood and agreed on, including a small percentage to the patentees. In order to provide "working capital" the stockholders assessed themselves in a percentage of their stock, which was set aside as "treasury stock" to be disposed of at whatever price it could be sold for. In this way some money was raised, but not enough to do any real business, and consequently nothing was done beyond making exhibition runs of the motors and getting flourishing accounts into the newspapers, on the strength of which, the individual members "peddled" their stocks.

Among those who bought stock was a gentleman of means, as well as culture and refinement, and strict integrity. In some way, he was induced to loan the company money from time to time on its notes, and this kept it alive a while longer. Indeed, it began to look as if some real business might be done after all. A compressed air locomotive was built, and tested on the elevated railroad, which succeeded in hauling their four-car trains, loaded with passengers, the whole length of the road; making all the stops to receive and deliver passengers, making the schedule time, and, in fact, doing practically everything which the steam locomotives were required to do. At the end of the trip it was found that a sufficient surplus of compressed air remained in reservoirs to insure against possible failure; and, as will be shown later, the economy was beyond question. For some unexplained reason, however, this success was not followed up, and eventually a sudden and complete collapse was brought about by the sudden and sad death of the gentleman referred to, in whose estate the company's overdue notes were found.

The inside workings and manipulations of this straw company, with paper capital, would make interesting reading; but I trust enough has been said in the brief space allowable here to show that it was not an organization well calculated to make a commercial success of such an undertaking, and is my explanation for the project being abandoned. Needless to say it was a great disappointment to me. Those desiring to investigate further can be furnished with plenty of evidence as to the practical utility of the system and the mechanical success of the experimental motors.

I shall now endeavor to derive approximately from the data obtained during these experiments what the cost of equipping and operating a railroad would be, and here it must be explained that the compressing plant used for these experiments was of cheap construction and small capacity; so that the actual cost in coal of making a few trial trips with a single motor is no criterion of what the cost would be with a permanent plant. Fortunately, however, the volume of compressed air used by the motors in making these trips is positively known, so that the quantity needed to operate any railroad may be computed from the mileage. The builders of air-compressing machinery will then contract for furnishing the plant, and guarantee its performance.

The street motors, which were really cars having the compressed air reservoirs and machinery under the seats and flooring, used at the rate of 300 cubic feet of "free air" per mile; and when towing two regular horse cars, all with a full load of passengers, 480 cubic feet per mile. The elevated locomotive used 1,482 cubic feet per mile, hauling a train of four cars full of passengers. This might vary, more or less, about five per cent., but was practically constant. "Free air" means the equivalent volume at atmospheric pressure. The section of elevated railroad where the tests were made is eight and one-half miles long; and at the busy part of the day might run trains three minutes apart from each end of the road. This would require an air-compressing plant of sufficient capacity to replenish the charge of forty motors per hour, capable of running 340 miles, equal to a volume of 504,000 cubic feet of "free air" compressed to the necessary pressure. Such a plant will cost about $80,000, and would develop 2,500 horse power, which, at two and one-half pounds of coal per horse power, would consume 6,250 pounds of coal per hour. The builders of such machinery would probably guarantee a rate of consumption not exceeding two pounds of coal per horse power per hour.

To reheat this air would require 750 pounds more, so that 7,000 pounds would be required to operate 340 train miles, being about twenty-one pounds per train mile. As a matter of fact, the coal consumption with steam locomotives is from thirty-five to forty pounds per mile, and of a quality costing about twice as much per ton as would be necessary in a stationary boiler. The cost of compressed air locomotives would be about the same as steam locomotives of the same weight, so that the first cost would be greater by the difference between the cost of air-compressing plant and the coal and water stations.

On a street railroad 504,000 cubic feet of "free air" would operate 1,680 car miles at 300 cubic feet per mile, if the motors haul no trailers; and 3,150 car miles if they haul two trailers, or at the rate of four and one-sixth pounds of coal per mile, and two and two-ninths pounds of coal per car mile respectively. Of course it would be greater with a less number of miles operated. A railroad running only ten motors per hour at a speed of eight miles per hour, or eighty car miles per hour, might consume as much as seven pounds per car mile, but I think even that will compare very favorably with almost any other kind of motive power in use.

An air-compressing plant for this work will cost from $8,000 to $9,000, and a responsible builder of air-compressing machinery is willing to guarantee that the horse power will not exceed 150. This in so small a plant might use three pounds of coal per horse power per hour, and with sixty pounds more for reheating the air, would make the total consumption 510 pounds of coal per hour, equal to six and one-half pounds per mile for 80 miles. It is, therefore, safe and liberal to put it at seven pounds, to allow for unforeseen losses.

I think it is safe to assume, therefore, that both in point of practical utility and cost, aside from other advantages, compressed air is well worthy of favorable consideration from practical railroad men; and that it was no inherent fault of the system which led to its abandonment by the New York parties.

I have spoken of compressed air having advantages over other motive powers in use. Some of these may be here stated:

1st. The absence of all nuisance or danger.

2d. The capability of running anywhere that a track is laid, independent of overhead or underground connections.

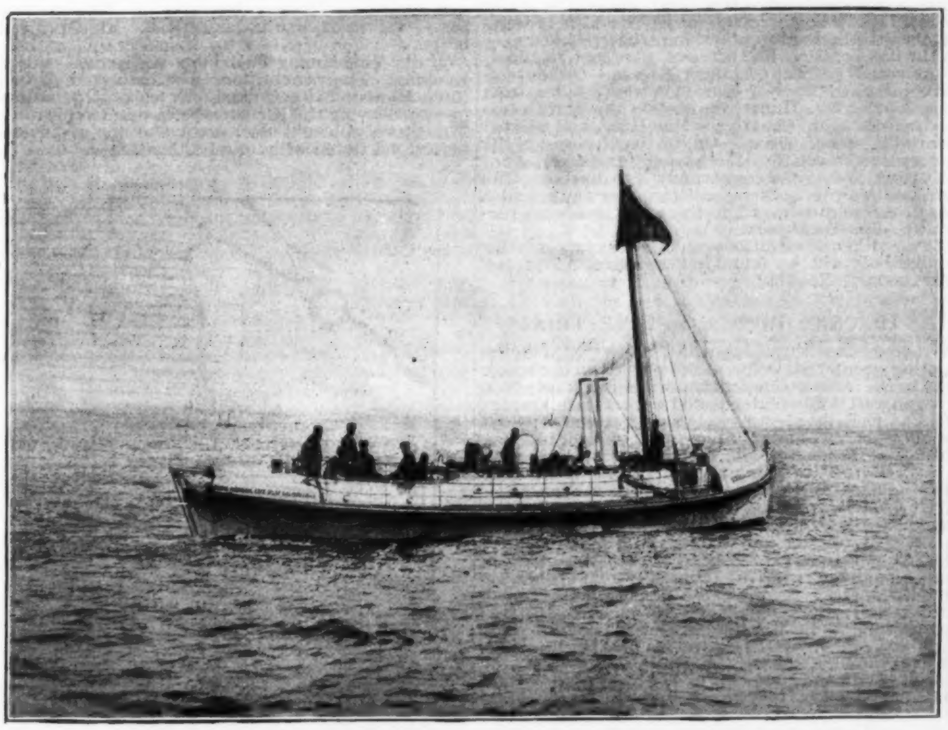
3d. A temporary stoppage of the power plant would not cause an immediate suspension of operation. Those who have been riding on a cable train when the cars came to a standstill, without knowing when they will start again, will appreciate this. Electric lines have similar trouble, as, for instance, when fuses and armatures burn out during electric storms, or otherwise.

4th. Economy.

Some may doubt this, but my figures and estimates are based upon facts derived from actual experiment and a knowledge of the possibilities. Those who care to investigate will arrive at the same conclusion. One thing which contributes in a large measure to economy of both operation and first cost is the fact that it is not necessary to provide for the possible contingency of starting up a large number of cars on the same line at once, as with cable or electricity. The compressed air motors would be recharged in regular rotation as they arrive at the charging station.

In conclusion, it will be seen that the preliminary work and expense of experiment has been gone through with, and now there is a ripe and abundant harvest for the reapers. ROBT. HARDIE.

439 So. Oakley Avenue, Chicago, Ill.



THE JET-PROPELLED STEAM LIFEBOAT NORTHUMBERLAND.

THE JET-PROPELLED STEAM LIFEBOAT NORTHUMBERLAND.

AT the beginning of 1888 a proposal for a steam lifeboat was submitted to the Royal National Lifeboat Institution by Messrs. R. & H. Green, the well-known shipbuilders at Blackwell, which, having passed through various modifications as the result of consultation with the committee and their professional officers, was accepted by the Institution, and a steam lifeboat, constructed of steel and propelled by a turbine wheel, was accordingly built and launched. The details of this novel lifeboat, which has been named the Duke of Northumberland, are as follows:

	ft.	in.
Length	50	0
Beam, moulded	12	0
Breadth, extreme	14	8¾
Draught, loaded (extreme), with three tons of coal, 30 passengers, 9 crew, and full outfit	3	3
Displacement, at this draught, 21 tons.		
Indicated horse power, 170.		

The advantages set forth and claimed for this lifeboat are as follows:

1. The propelling power of the vessel is instantaneous.
2. No racing, loss of power, or injurious effects to the machinery, however much she rolls or pitches.
3. The vibration usually experienced in a screw or paddle boat almost disappears.
4. As the engine only runs in one direction, the wear and tear of machinery is greatly reduced, and there is no loss of time due to stopping and reversing for going astern.
5. The management of the vessel is entirely in the hands of the officer on deck, who, by working two handles fitted on the after end of the engine casing, can thus control the jets, and stop dead, go ahead, or go astern without any communication with the engine room.
6. There are no serious obstacles under water to interfere with her sailing qualities, or affect her if she should take the ground or run foul of ropes or wreckage.
7. Should anything happen to the rudder, she can be steered with the turbine alone.

The measured mile sea trials give a mean speed of 9·15 knots. Tests were also made with her maneuvering power, which proved to be remarkably good, both by rudder and turbine. Going at full speed, she made with rudder a half circle in 35 seconds, and a full circle in 50 seconds. Going slowly, with rudder and turbine she made the full circle in 40 seconds, and with turbine alone in 52 seconds. By working the levers on deck the boat was brought from full speed to a dead stop in 32 seconds, and from a dead stop gathered headway in 4 seconds.

In September, 1890, the Duke of Northumberland was stationed at Harwich, where she gave general satisfaction. She contributed to the saving of thirty-three lives and two vessels. In February last she was sent to Lowestoft to take part in the towing tests in connection with the competitive trials of sailing lifeboats. She remained there about six weeks.

She is now stationed at Holyhead, where she lately rendered the following service: On the 27th of October, 1892, the lifeboat went out four times. 2:45 a.m.—On the first occasion her services were not required, as the vessels got out of danger. 4 a.m.—On the second occasion the crew of four men were landed from the schooner Miss Hunt. 7 a.m.—On the third occasion the boat again went to the Miss Hunt, and assisted to save the vessel. 10 a.m.—On the fourth occasion she rendered assistance to the schooner Janets and Ann, of Chester, towing the vessel safely into harbor. The wind was blowing a strong gale from the south, and a heavy sea was running while these services were performed.—*The Yachtsman.*

[Some other illustrations and particulars of this peculiar boat will be found in SCIENTIFIC AMERICAN SUPPLEMENT, No. 770.]

THE RECENT RUSSIAN PLATE TRIALS.

WE give herewith sketches and notes taken on the shooting ground at Ochta of the effects on the armor plate in the recent competition which took place on November 23. The plates tested were the following:

(1) Cammell—hard—all steel (Figs. 1, 2, and 3): First round: Shot rebounded intact; penetration, 13½ in.; S. V. 2,198. Second round: Clean through, corner off; S. V. 2,195. Third round: Shot broke, point just touching backing; half plate fell down; S. V. 2,203.

(2) Cammell soft steel (Fig. 4): First round: Shot lodged, base 5½ in. in; S. V. 2,190; penetration, 21½ in. Second round: shot lodged, base 3 in. in; S. V. 2,198; penetration, 19 in. Third round: Head lodged, base rebounded; S. V. ? Fourth round: Shot rebounded intact; S. V. 2,178; penetration, 12¾ in. Fifth round: Shot rebounded intact; S. V. 2,205; penetration, 12 in. Sixth round: Shot lodged, base 4½ in. out; S. V. 2,183; penetration, 11½ in. No cracks 'till sixth round.

(3) St. Chamond all steel (Fig. 5): First round: Shot rebounded broken in two; S. V. 2,188; penetration, 12 in. Second round: Shot rebounded intact; S. V. 2,198; penetration, 12 in. Third round: Shot rebounded intact; S. V. 2,178; penetration, 11 in. Fourth round: Head lodged, body rebounded; S. V. 2,198. Fifth round: Head lodged, body rebounded; S. V. 2,189. Sixth round: Shot rebounded intact; S. V. 2,191; penetration, 12 in. No cracks. Plate seems to have been Harveyized, but not chilled.

(4) Ellis-Tresidder compound (Figs. 6, 7, 8, 9, and 10): First round: S. V. 2,176. Second round: S. V. 2,182.

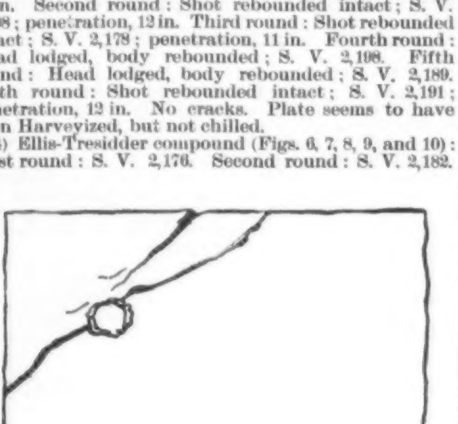


FIG. 1.

Third round: S. V. 2,177. Fourth round: S. V. 2,198. The mark shows the point of impact for the fifth round, S. V. 2,197. All penetrations from 4 in. to 6 in. deep. All projectiles broken small. Backing uninjured. Middle steel at fractures quite black, as if old cracks at many places. The face was perfect and the welds were excellent. Some curious defect in the middle steel seemed to account for the plate breaking so badly. Nevertheless the backing has been better protected than by any of the other plates. Frost, 2 deg. Reaumer. Snow falling.

(1) Cammell—hard. The effect of the three rounds, 1, 2, and 3, are shown. It will be seen that the penetration of 13½ in. is accompanied by cracks across the corner, and at the second and third rounds portions of the armor had become detached and the firing ceased.

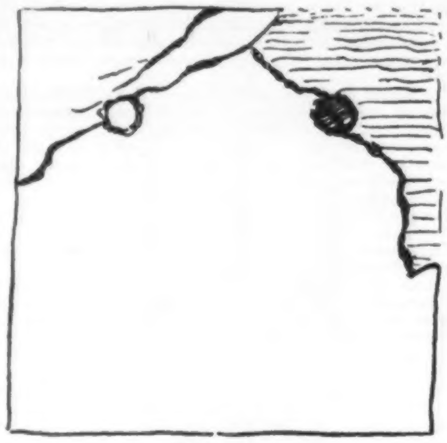


FIG. 2.

(2) Cammell—soft—bore six rounds and only showed a crack in the last round. The penetration was in one case 21½ in. and in one only 11½ in. This plate behaved very well, but is rather soft. One projectile broke.

(3) St. Chamond. This bore six rounds without cracking. The penetrations measured were 12 in. in three cases and 11 in. in one. Three projectiles broke in two, leaving the heads embedded in two instances. This was a splendid steel plate, and one of the most perfect yet tested without a hardened face.

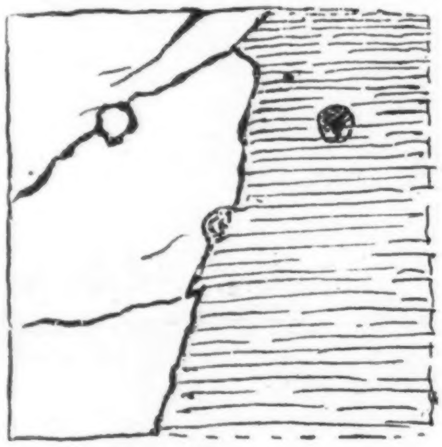


FIG. 3.

(4) Ellis-Tresidder plate, which bore five rounds only, braking to pieces from some defect in the steel, but breaking up the projectiles completely.

Taking the plates as they stood, so far as the sketches exhibit the results, the St. Chamond is decidedly the best, and then Cammell's soft plate. Nevertheless, as we have before remarked, we think that 12 in. penetration is too much under the conditions of trial, and that the faces must be hardened to promise any future to plates. The Ellis-Tresidder plate's failure will probably make it difficult for it to win confidence

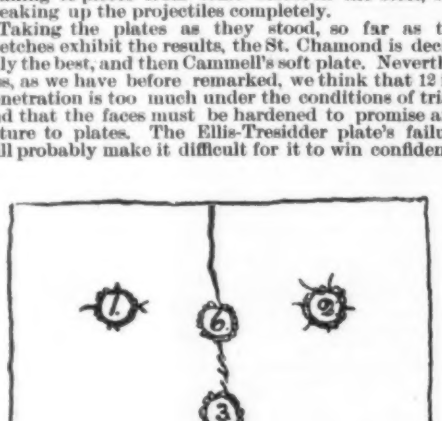


FIG. 4.

abroad. It is, however, in our judgment, a question only of time, judging from our own English trials. The account of the conclusion of the trials, which we notice elsewhere, shows how completely Harvey's plate keeps up the credit of the hard face.

It is desirable to make a small correction in our previous article. There is no difference between the muzzle velocities of the 6 in. guns at Shoeburyness and on board the Nettle, hence when fired at the same distance from the plate the striking energies are the same; consequently the few feet difference we have recorded are due only to the fact that the velocities were not measured, and a rather lower estimate had been made in the case of Shoeburyness than of the Nettle. The two tests must be regarded as identical when the same projectiles are used at the same close ranges.

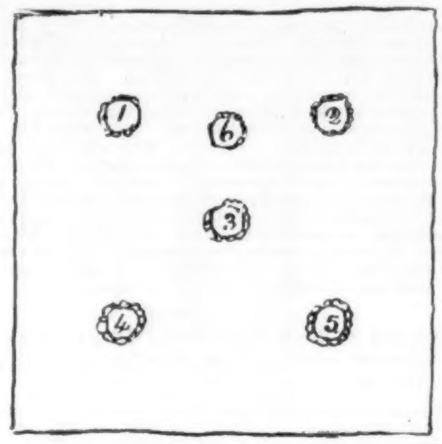


FIG. 5.

The *Times* lately contained a short account—telegraphed from St. Petersburg—of the conclusion of the Ochta trial on December 14th, 1892. The Harvey plate, made by Messrs. Vickers, has been completely successful. Firing was commenced at this plate exactly in accordance with the programme, the 6 in. gun firing Holtzer forged steel projectiles, weighing about 90 lb. English, with an average striking velocity of 2,173 ft. per second. These projectiles broke up in the hard face. The points being firmly held in the plate, the penetration can only be guessed. It ap-

FIG. 6.

peared to be about 4 in. or 5 in. Four projectiles fired in succession behaved in the same way, and no cracks were made. It was then decided that the competition should be declared at an end, the Harvey plate having already proved itself to be the best.

Advantage was now taken of the resisting power remaining in the plate, to test the effect of heavier blows. A 9 in. projectile, weighing 406 lb., was fired with a striking velocity of 1,655 foot seconds from the 35 caliber gun. This penetrated and broke up, fracturing the plate in fissures running through the pre-

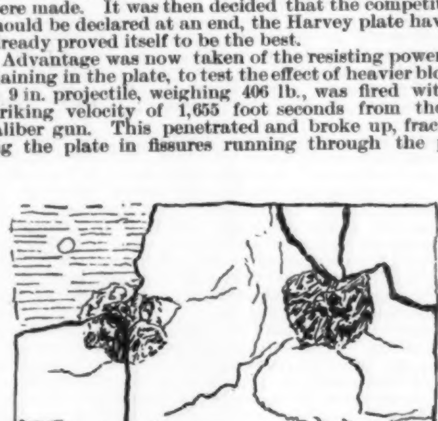


FIG. 7.

vious points of impact, but no part of the plate fell; no bolts were broken, and only one bent. A second similar 9 in. projectile was fired with a striking velocity of 1,889 ft. per second. This broke up, but brought down the whole plate in fragments, together with the woodwork and backing. The shell point, which was broken, just reached the wrought iron skin behind the backing. The wood was set on fire. It was considered

that any supporting structure behind armor and backing would have been wholly uninjured.

Harvey is to be greatly congratulated on the complete success of his plate, which has behaved exactly in the way a plate, in our judgment, should behave. It broke up the projectiles from the 6 in. gun without cracking, and so abruptly as to prevent the shot receiving support from surrounding plate, and to

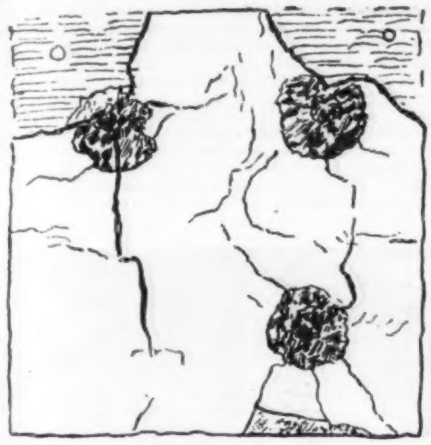


FIG. 8.

cause a great part of the blow to fall harmlessly on it in the form of fragments. When a blow altogether outmatching the plate is delivered on it, the plate breaks up in every direction, instead of letting the shot through. This again is good behavior. When altogether outmatched, we hold that armor ought to behave in this way, that is to say, it ought to call on all the resisting powers it can bring together and stop the projectile, and save the structure behind it at the cost of its own destruction. It is chiefly on the thin armor

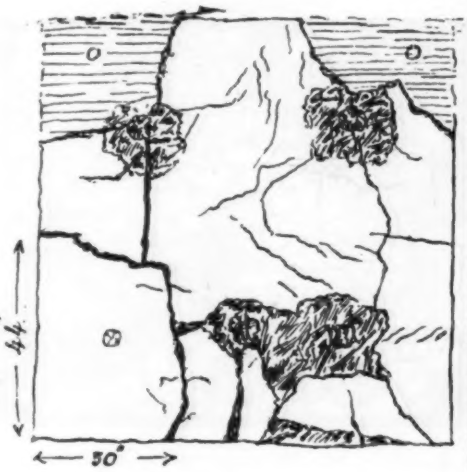


FIG. 9.

of cruisers, and on the thinner parts of heavily clad vessels, that such overpowering blows will fall. In either case it is desirable that the armor should be destroyed rather than what it protects. The cruiser is not intended to stand up against long-continued fire, and in the gun battery or upper structure of a ship the destruction of plates will not produce the awkwardness that would arise with *debris* at the water line, and clearly will not disable the ship to the same extent as if the guns and mountings received the projectile.

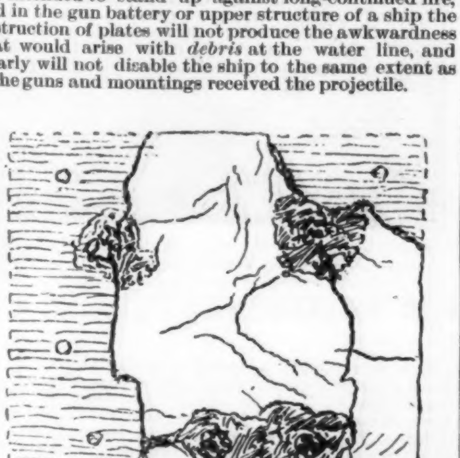


FIG. 10.

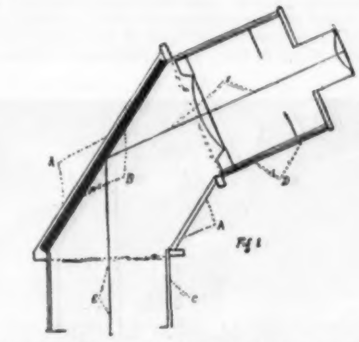
We hope to see the Ellis-Tresidder behave in the same way; in fact, we almost think that its American rivals must join with us in regretting that such an unfortunate specimen went to Ochta. Once admit that this trial plate was altogether inferior to those recently tested in this country, and it follows that the scientific interest of the competition in some measure suffered.—*The Engineer.*

THE ANALYZING EYE PIECE.

By WILLIAM LIGHTON, Omaha, Neb.

AT the first meeting of the American Society of Microscopists, held at Indianapolis, I presented a paper upon an analyzing eye piece, and exhibited one that I had been using for several years. I sent, at a later date, a drawing and description of it to the San Francisco Microscopical Society. I have had many letters from microscopists since that time asking about the appliance, and I have been strongly urged lately to present the matter through the *American Monthly Microscopical Journal.*

The apparatus consists of a box, A, of the form shown in the side view, Fig. 1, made of either metal or wood, and containing a plate of polished black glass,



LIGHTON'S ANALYZING EYE PIECE.

B. At the lower part of this box is a short tube, C, which fits into the draw tube of the microscope, and at the opposite angle of the box is another short tube, D, which receives the eye piece. The glass plate is used for the purpose of reflecting the beams of polarized light at the best analyzing angle. It will be necessary, of course, to use some form of polarizer below the object upon the stage of the microscope, and the best is the Nicol prism.

The line, E, represents a ray of light which has been reflected by the concave mirror through the Nicol prism and objective, and is reflected by the polished surface of the glass, B, through the axis of the eye piece, as shown by the line, F. G represents the eye piece.

The exact angle of inclination of the polished surface of the glass to the line, E, which represents the axis of the microscope, is very important.

This angle should be 146°, which will cause the reflected beam, F, to form an angle of 112° with the line, E, which is the correct angle for a reflector of polished German plate glass, now to be described.

If a piece of black glass cannot be obtained, procure a piece of perfectly polished German plate looking glass, 2½ in. long and 1¼ in. wide. Scrape off the silver surface and thoroughly clean. Paint the cleaned surface quite heavily with black paint. Plate glass of a dark green color, when examined edgewise, is best.

A diaphragm, L, with opening about the diameter of the field lens of the eye piece should be placed at lower end of the tube, C.

It is hardly necessary to state that this piece of apparatus is used an analyzing arrangement instead of the Nicol prism analyzer placed above the objective. The following are some of the valuable features of this arrangement:

It allows the entire angular aperture of all objectives to be used, which is not the case when using the Nicol analyzer and large angle low power objectives. The stage can be kept in a horizontal position in chemical experiments and in the examination of fluids, and the line of vision for the worker is the very convenient one shown at F. The image of very delicate objects is free from distortions, which is rarely the case when using a Nicol analyzer.

The analyzing eye piece can be revolved in the draw tube of the microscope by means of the tube, C, giving the usual effects of a revolving analyzer.

It is well to use a hemispherical lens of about ⅝ of an inch diameter above the selenite film and polarizing prism, with the convex side of the lens toward the object upon the stage, and the upper part of this convex surface about ¼ of an inch from the object.—*Am. Micro. Jour.*

SMALL PRISMS FOR LIMELIGHT POLARISCOPES.

THE maximum size objects provided for the ordinary polariscope reach up to one and three-quarter inches, and for these an aperture of about three inches has been considered necessary, and Nicol prisms, or substitutes for them having similar internal dimensions, were generally recommended.

Of course, prisms having only two inches, and even so small as one and a half inch, field have been used, but it has been supposed that these small sizes could not show the maximum size objects. With the lantern microscope, prisms of only three-quarter inch field have been supplied, but these were intended only for showing microscopic objects, and the instrument as a polariscope was not intended to be used for larger objects.

Let us now inquire if the large size, such as three inches, is at all necessary.

Some very reliable authorities have assured me that they are not, and that prisms of one and a half inch field are quite sufficient; and now I go a step further, and maintain that, with a one and a quarter, or even a one inch field, all that is needed can be done. With this small size the loss of light is very appreciable, and the dimension covered is very little less than with the three inch prism, *if used in the right way.*

In days gone by it was customary to use large prisms, not only for polarizers, but also for analyzers. I can remember a friend of mine who possessed a three inch Nicol polarizer expressing his regret that he had not also a three inch analyzer, as the one he was then using had only a two inch field. Soon after this, however, *it began to be thought* that an analyzer of half inch field gave just about as good results as others of the largest dimensions. As time passed on, *it began to be realized* that this was a fact, and at the present day small analyzing prisms are adopted in *all* polariscopes.

Well, I think the time has arrived for us *to begin to think* that large polarizing prisms are just as useless in proportion as large analyzers have been found to be, for then we shall the sooner *begin to realize the fact.*

However desirable larger blocks of Iceland spar may be, either as a commercial article or for prisms, or anything else, we know that the natural supply of the mineral has become practically exhausted, and even now a one inch prism is a precious article. So, as it is a maxim in philosophy that if we cannot bring things up to our mind we must carry our mind down to the level of things as they are, I can console myself by showing that a prism of one inch field will exhibit the maximum size objects sufficiently well to answer every practical purpose.

Of course, I shall be fully prepared for some opposition from prejudiced individuals and others commercially interested. Changing from a large to a small prism for analyzer was but a small affair, involving so slight alterations in the construction of the instruments that nothing was affected except the reduced price of the prism; but when it can be shown that with a small lantern microscope having suitable prisms of say one inch or one and a quarter inch field results can be produced to equal those obtained by the most elaborate instruments, costing 30*l.* to 100*l.*, the case is somewhat different.

Independent of its own cost, a large prism determines in the main the style and cost of the whole instrument, and, as I have said, this large size and elaboration is totally unnecessary, a sheer waste of money and of no benefit to any one but those who are commercially interested.

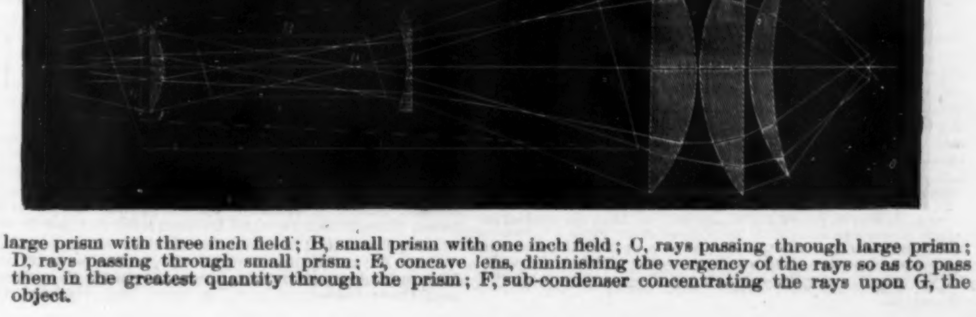
With the elbow polariscope, a large field is indispensable. The glass plate forming the polarizer must be from four to five inches long, by reason of the polarizing angle. A less size would not cover the one and three quarter inch objects, and on account of its form and size, it must of necessity be ungainly in use. I may here refer to a circumstance which occurred the other day as an illustration of this.

A well-known scientist of Manchester, possessing one of these elbow polariscopes, took it to an optician to be fitted to a new lantern. "No," said the optician; "do not use this obsolete instrument, but let us take the analyzer out of it and use it as a polarizer." This was done, and as the prism had a full one inch field, better results were obtained by it, and an analyzer of half inch field, than had ever been obtained, or could ever be obtained, by the elbow polariscope in any way.

The appended diagram, drawn to scale, shows the rival prisms and their arrangement.

The rays pass convergently through the large prism, and do not require a sub-condenser before passing through large objects; but with a small prism a sub-condenser is required because so many rays leave it divergently. A large lantern condenser is not required with the large prism, as nearly all the rays outside the three inch field are cut off or do not enter the prism. It cannot be used further than shown from the condenser, as that would cause the converging cone to be too small to fill the object, or to enter the objective in the best conditions for evenly illuminating the screen.

Some writers represent the concave lens E as passing the rays through the small prism in lines parallel with its sides, and accordingly call the lens a "parallelizing" lens; but, having field lenses of all foci from nine to twenty-two inches, and found none which, wherever placed or however used, were capable of passing the rays in any such like manner through the prism, I consider the designation misleading, and I do not use it. I do not even pretend that I have correctly represented the rays just as they pass through the lenses and the prism, but the diagram gives a sufficiently accurate idea of the path of the beam to show how it is to be managed when an object has to be illuminated



A, large prism with three inch field; B, small prism with one inch field; C, rays passing through large prism; D, rays passing through small prism; E, concave lens, diminishing the vergency of the rays so as to pass them in the greatest quantity through the prism; F, sub-condenser concentrating the rays upon G, the object.

which is larger than the field of the prism, and if the beam is properly managed there is not much to choose between the illumination obtained by the different prisms, nor the size of objects that may be covered by them.

With the small crystals used in the polariscope, whether uni-axial or bi-axial, shown either by narrow angle or very wide angle rays, there is no reason why the smaller polarizing prism should not bear the palm, seeing that the crystals are so small, and require every advantage in the arrangement for transmitting rays through a very small aperture.

By using a Nicol polarizer in the way I have advocated some precaution must be taken against injury to it by transmitted heat, and an alum trough or a water trough does this most effectively. The concave lens undoubtedly affords some protection to the prism, but it may be said to show how small is its effect that I know of three Nicol prisms that have been ruined by heat passing through them where the alum or water trough has inadvertently been omitted. In one of these cases the balsam was blown up into bubbles, and in the other two cases the ends were "frosted" so as to require repolishing.

I confess that a Nicol prism, large or small, is a delicate thing to use in a lantern; it is also costly, whatever be its size. Then those who prefer something less expensive may use polarizing bundles (glass plates) with transmitted light, and when placed in the posterior part of the microscope and used just in the same way as the prism, very good results may be obtained by them. I have not unfrequently during an exhibition substituted a bundle for a Nicol, with so little alteration in the result that only an expert could have discovered the difference. Still the prism gives the most beautiful results, which for richness and splendor of color surpasses everything else in the range of optical science.—*W. Leach, Stereoscopic Club.*

JAPANESE STENCIL PATTERNS.

In this country we are accustomed to consider stenciled patterns as an inferior and mechanical method of producing ornament, only to be countenanced from motives of sheer economy and as a bad substitute for free hand design. The beautiful collection of Japanese stenciled patterns which Mr. Tuer has put forth* is calculated to make one regard this art from a new point of view. In the deft hands of the Japanese it appears that stencil may be made to lose much of its mechanical appearance, and that it can be made the medium of producing diaper patterns in which the stiffness and formality supposed to be inherent in stencil work are so happily masked that we can almost forget the manner in which the work is produced.

Independently of the faculty of the Japanese for the production of free and informal-looking repetition designs, there can be no doubt that some of the freedom and delicacy of the designs illustrated in this book is due to the material in which the stencil plate is made. We are accustomed to use stencil plates of thin metal or thick card or pasteboard, in which it is difficult to cut a fine line. The Japanese use a tolerably thin brown paper, in which the pattern is cut out double, the two pieces being then pasted together, with, when necessary, a series of threads pasted in between them and crossing the openings, so as to assist in holding the whole together, while not interfering perceptibly with the design. Such is the account given by Mr. Tuer, who says in his title page that he "knows nothing about it," but appears to have taken a little trouble to investigate the process.

These auxiliary threads are not present or necessary in all designs. They are employed when the character of the design is such as to lead to a number of rather long slits in the pattern without sufficient cross support.

In general, however, the Japanese designers are exceedingly ingenious in devising their stencil patterns so as to preserve a sufficient amount of lateral support to the solid portions without interrupting the apparent freedom of the design. The stencil pattern being cut out of the thin paper with a small sharp knife, used more like a graver than a knife in the ordinary sense, allows of a freedom of line and delicacy of detail which are impossible in cutting from a more tough and stubborn material. On the other hand, it cannot be denied that the use of this more fragile material militates against the life of the stencil plate, which is much more quickly worn out than one of more robust material. But this, perhaps, can hardly be said to be a disadvantage from an artistic point of view; it tends to prevent the repetition of a design *ad nauseam*, and affords scope and temptation for the continual production of new patterns. In Mr. Tuer's publication one of the original stencil plates is bound in as a kind of frontispiece to each volume, so that the possessor can have by him not only the results, but an example of the means by which they are produced. A different stencil plate is inserted in each copy, so that each has a certain individual character so far as this addition is concerned.

We have to thank Mr. Tuer for permission to reproduce on a reduced scale four out of the 104 designs contained in his book, and may draw attention to some of the characteristics displayed in them. Fig. 1, reproduced to half the original size, is an example of a class of ornamental work to which the Japanese are very partial in painted designs, consisting of birds at different angles, the lines crossing each other and filling up the ground of the ornament. This is a repeating pattern in one direction only (vertically), being apparently intended for an upright panel of the width of the design; but the idea of mechanical repetition would certainly not force itself on the eye in execution, if the repeats were carefully laid down. In this and all the others the dark portion of the design represents the solids of the stencil plate and the whites the openings. In the long white wing feathers of the birds, it will be seen how cleverly the artist has managed to provide cross ties by giving a black banding to the white feathers, which seems to come in quite naturally and helps the effect of the design, while it provides the necessary stiffening for slits which would otherwise be too long to stand the working without wrinkling up.

In Fig. 2 a most effective piece of conventional floral diaper, the mechanical conditions of the process are again made to lend themselves to the spirit of the design; in the white flowers the lines, which form the bars, are necessarily continuous, in the dark ones the lines, which are cuts in the paper, are necessarily discontinuous, and appear as if sketched in lightly, thus giving to the two classes of flowers a contrast of style and texture which arises naturally out of the conditions of the process.

Figs. 3 and 4 are smaller stencils, reproduced here a little more than half size. Fig. 3 is charmingly ingenious, the figures of the moths being produced, as will be seen, simply by a thinning of the parallel bars of the stencil, so that the forms of the insects come out in a half-shadowy manner, quite different from the effect of hard outline generally seen in stencil work. Nothing could be more characteristic of the delicate instinct of the Japanese in this kind of work than this incident. This is one of the stencil plates into which cross threads are worked, the nature of the pattern requiring this support.

Fig. 1.

Fig. 2.

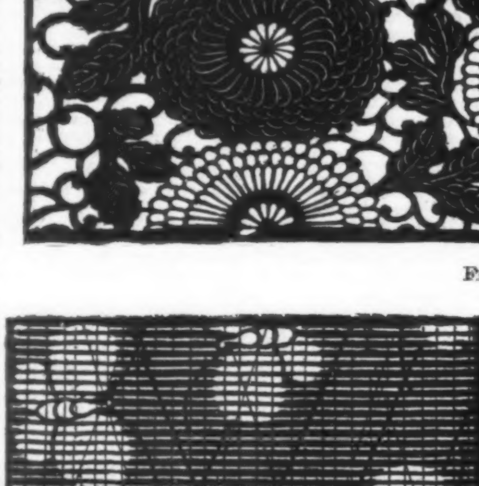


Fig. 3.

Fig. 4.

JAPANESE STENCIL PATTERNS.

Fig. 4 is an example, one of several in the book, of the decorative effect which can be produced by a mere arrangement of pin holes; not "pin holes" literally; the Japanese is much too neat a workman for that; pin holes would leave a raised burr which would spoil the working of the stencil; all the little holes are punched out.

These examples will be sufficient to indicate that there is a degree of decorative poetry to be got out of stencil work such as we very seldom achieve or even aim at in England. Not that we consider all the designs in the book as admirable as these which we have selected. Some of them are too grotesque in effect, and too angular and abrupt in line; some of them are mere imitations of basket work and hurdles and such things, which (Japanese or European) are in false taste, though they are all treated with a vigor of execution which gives them a certain interest. There are a good many others, however, quite equal in artistic feeling and originality to those we have reproduced, and their variety of *motif* is most remarkable. One shows delicate meandering sprays of flowers, as if drawn with a pencil; in others scattered conventional leaves or flowers seem to emerge from a groundwork of netted or waved lines; in another, a series of Japanese parasols are combined into an effective diaper; another consists of a number of little dot-and-dash sketches of figures of men in all kinds of attitudes, indicated only in a highly conventionalized manner, making a spotty pattern, the real constituents of which are only recognized on a close inspection. This is one of the curiosities of the book, rather than one of its beauties; but the beauties are predominant, and it is a book which every ornamentist may be glad to possess.—*The Builder.*

* The Book of Delightful and Strange Designs, being one hundred facsimile illustrations of the art of the Japanese stencil cutter, to which the gentle reader is introduced by one Andrew Tuer, F.S.A., who knows nothing at all about it. London: The Leadenhal Press, and Simpkin, Marshall & Co. London, Paris and Yokohama: Liberty & Co. New York: Charles Scribner's Sons. Paris: Baudry et Cie. Leipsig: Brockhaus.

STORAGE BATTERY CARS.

Messrs. Charles Paine & Sons, of New York, have reported upon the use of storage batteries for traction, for Mr. J. D. Hawks, General Manager of the Citizens' Railway Co., of Detroit, Mich. We give the following abstract:

You particularly requested us to investigate the systems of electric accumulators of the Hopedale Electric Co. of Boston, Mass., in use on the street cars of Milford, Mass., and of the Accumulator Co., of Philadelphia, Pa., in use in Washington, D. C. In addition to an examination of these two systems, we have made a study of the general subject, and have consulted several of the engineers who have made this branch of electrical work their specialty.

The only information to be obtained regarding the cost in this country of equipment and operation of street railroads using storage batteries as a means of traction is from those who are directly interested in their sale, and for reasons that are apparent they are quite reluctant to give any information. What they do give is meager, and even that is made questionable by contradiction and absurd statements.

The Accumulator Company, of Philadelphia, Pa., has done much of the accumulator traction work in this country during the last four years, having equipped with its system many roads, but at the present day there is only one of them in operation (at Washington, D. C.), not yet turned over to the owner of the road,

but being operated under contract by the Accumulator Company, who declined to state the details of the cost of operation. We were dissuaded from going to Washington, which, without their cordial consent, would have been useless. We have been able to extort from this company only a valueless statement lumping the whole cost of equipment, generating station, cars, etc., with their electrical apparatus, although we had particularly said that we did not want estimates on the generating station or cars, simply on their electrical apparatus. The Accumulator Company evidently wished to be civil and also to avoid giving away information, except that they now recommended that batteries should be frequently changed, after a run of about ten miles, thereby lessening the weight of battery to be carried somewhat, and prolonging the life of the battery by using it only at the beginning of its discharge. They think such frequent handling, say at every round trip, will be more than compensated by the increased life and efficiency of the battery. They state that when one trailer is drawn, it also must be provided with its own batteries, which shall be connected with those on the motor car; when two trailers are needed, it is thought that the two carloads of batteries together will be able to pull the third without any batteries.

The Consolidated Storage Co., of New York, has had large experience in the use and manufacture of storage batteries in this country, and more than any, with the possible exception of the Accumulator Company, in their use for traction purposes. Their batteries are almost identical with those of the Accumulator Company, and in their equipment of cars on the Fourth Avenue line in New York they use about 3,800 lb. of batteries per car. In a conversation with their president we learned from him that his company was no longer in the traction field; that they would sell batteries to any one who wished to purchase them and for any purpose.

We visited the electric road at Milford, Mass., and got what information we could about it. The road is owned by one company, and another is the manufacturer of the system employed upon it, batteries, motors and all. The officers of the two companies are the same men, and probably the stockholders are also the same. The road has been in operation one or two years (one car now running), yet the superintendent of both road and factory, and the inventor of the whole system, said they were "now trying some new batteries, which, from every indication, would be what they wished to put in the market," but that at present he was unwilling to give any information.

The president of the electric company was equally uncommunicative. We are quite sure, from a glimpse of a battery caught in the office of the superintendent, that it is only a modification of the type of battery already described, and from a published report we learn that on a recent test a car equipped with two 7½ horse power motors was run by a battery of 136 cells, each weighing 33 lb. (total weight of battery 4,488 lb.), 2882 miles. The car carried a load varying from 7,680 to 9,174 lb., and on a run of 6,440 ft., in which occur grades of one to two per cent., the car ran at the rate of nine miles per hour.

Considering your specification of requirements, that cars shall make 150 miles per day, running 15 miles per hour and hauling two trailers, we are compelled to estimate the weight of lead battery to be carried at 5,000 pounds per car, which will, perhaps, not be sufficient during snow storms and during icy weather. This dead load is of itself a tremendous handicap upon any scheme of storage battery traction. It is evident that operating by the storage battery system involves all the expenses of the trolley system, except the small item of maintenance of the trolley and trolley wire, and has, in addition, to bear the cost of transporting, maintaining and handling the batteries. What might be saved in the cost of generating station and overhead construction would, in your case, probably be much more than offset by the cost of batteries.

There are no figures available in this country except what may be taken from the vague statements of those interested in the sale of storage battery apparatus, and none of them who are now in business have had anything like experience enough to know what the cost of operating would be when conducted on a large scale over a long period of time. We do know that the Citizens' Street Railway Co., of Indianapolis, Ind., experimented for about six months with two cars equipped with storage batteries, and returned to the use of mules for two months; after another experiment with the batteries under the care of an agent of the Storage Battery Co., they say: "It was so very expensive and the operation was so unsatisfactory that we finally withdrew them from the road and put up the overhead construction, and are now using the trolley system with great satisfaction." This company estimates that it cost about double to operate the cars with storage batteries that it does with the trolley system.

We have the published report of the Birmingham Co. in England, for 1891-92, which is operating a section of its own road with storage batteries, which contains a comparison of the total cost per car per mile run by several methods of traction, as follows:

	Per car mile.
By storage battery	30·78c.
By horses (teams and buses)	19·92c.
By cable	12·36c.

The returns for the storage cars cover a distance run of 188,760 miles. We are informed that there are 12 storage cars in operation, making an average run for each of 15,730 miles. This comparison confirms the statement made to us by the most experienced manager of storage battery operations in this country, and long at the head of one of the principal storage battery manufacturing companies. He estimates that the total cost of installation and operation of a storage battery road for ten years would balance the total cost of installation and operation of a cable road for a like time.

We are satisfied that no positive results have been attained anywhere which would justify any company operating horse car lines to substitute storage batteries for the horses. It has not been shown that the storage battery can be depended upon for power under the circumstances which prevail during a Detroit winter, nor can the batteries be conveniently arranged upon the open summer cars. We are, therefore, unable to conceive of any reasons which would lead the Detroit Citizens' Street Railway Co. to make use of the storage batteries for operating any part of its system.

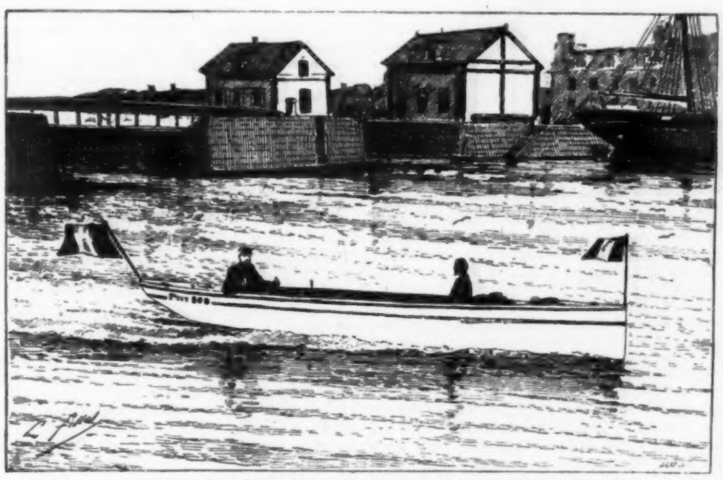
A STORAGE BATTERY EXPERIMENT ON NINTH AVENUE.

AN electric car equipped according to the system of the Acme Storage Battery Company, of this city, is now being operated experimentally on the tracks of the Ninth Avenue street railroad. This car weighs 6¼ tons and is provided with 144 cells, each weighing 27 pounds and having a capacity of 140 ampere hours at an average discharge rate of 25 amperes. The grades on the Ninth Avenue road, from 54th Street to 116th Street, a distance of three miles, are exceedingly heavy, one of them, at the end of the route, being no less than six per cent. for a distance of more than 200 feet. On the up trip 31 amperes are usually consumed; a capacity of 75 amperes may be called upon at any time.

The time usually occupied on the up trip is 24 minutes and 50 seconds. On the return trip, during which the grades are mostly descending, the average current drawn from the battery is 19 amperes, or little more than half of that required on the up trip. The average time of the down trip is about 22 minutes and 30 seconds. The entire trip both ways has been made in 47 minutes and 20 seconds. A specially designed motor, the company alleges, is one of the features of this system. The aim has been to make a cell which, while having the least weight for its storage capacity, shall at the same time be so constructed as to avoid the deteriorating influences which have usually caused the rapid destruction of storage cells employed in this class of work. The car made one trip recently when the tracks were in a wet and slushy condition. A fair speed was made and maintained on all the grades. The company manufacturing this system claim that they can run their cars at a cost of only nine cents a mile.

THE ELECTRIC LAUNCH P'TIT BOB.

THE boat herewith illustrated was constructed at Cherbourg after plans by Lieutenant of the Navy Chapelle, and was tried in the commercial port. Its motor consists of an Edison dynamo. The shaft of the armature ring is prolonged beyond the stern of the boat, and carries a screw 16 in. in diameter and of 7 in. pitch, which turns at full speed at the rate of 1,500 revolutions per minute. The energy is furnished by 50 accumulators of lead, and with ebonite vessel, each weighing 29¾ lb. These accumulators are divided into two series that are capable of being grouped in tension or in quantity, thanks to a special commutator.



THE ELECTRIC BOAT P'TIT BOB.

Owing to the position of its accumulators and despite its slight breadth, the P'tit Bob is very stable. The maneuvering is effected through three levers, one for actuating the rudder, one for reversing the current in the dynamo, and one for controlling the coupler and causing the machine to revolve at high or low speed. The net cost of the boat was $860, but such cost will diminish in measure as this kind of boat is improved.

The trial of the boat may be considered as having been most successful.—*Le Monde Illustré.*

INDUCTOSCRIPTS.

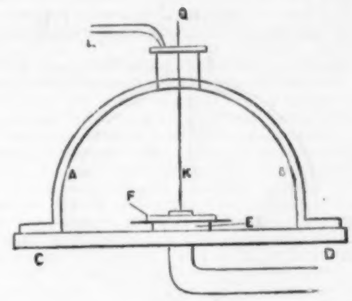
THE well known "breath figures" of Moser, Riess, and Karsten suggested to Mr. F. J. Smith, M.A., in 1878, the idea of producing similar figures on photographic plates. Grove once tried to set the image by coating an electrified plate with collodion and nitrate of silver, but he did not let the electrical discharge act upon the silver salt. Karsten failed to produce fixed pictures of these breath figures on daguerreotype plates, while Moser's water vapor pictures were not permanent effects.

By means of an ingenious combination of apparatus Mr. Smith has recently succeeded in producing these figures on photographic plates under varying circumstances. The experiments were performed under a bell jar, A, B (*vide* figure). This was placed on the plate, C, D, of an air pump; a round copper disk, E, was supported on the pump plate on three points; on this disk a sensitive plate, F, was placed, and on this the coin, the print of which was to be produced.

The electricity was introduced through the copper rod, K, the plate and rod being connected to the terminals of an inductorium or transformer, driven by four accumulators in series, each having seven plates, 12 in. × 12 in.

By means of the curved tube, L, different gases were introduced into the bell jar. The intensity of the spark could be regulated by bringing the terminals of the inductorium together. The output of the transformer was regulated by resistances put into the primary circuit; also by the rate at which the reversing commutator was driven; this commutator was similar to that used on the early Siemens machine.

The gases used were air, oxygen, and coal gas; the pressure in the receiver was generally 760 mm.; the time of the exposure varied from 2 to 50 seconds, the



temperature from 5° to 100° C. The best results were obtained with oxygen gas.

Mr. Smith's experiments were entirely successful. In addition to pictures on photo plates, good impressions were obtained on bromide paper and other papers direct; he also obtained good pictures from woodcuts after they had been liberally sprinkled with plumbago. These pictures, of course, were produced on development in the usual way.

These experiments show that a potential difference greatly under that of a jar discharge or that of an electric machine will upset the chemical equilibrium of a photo plate. But several factors appear to contribute to the result, namely: The potential difference, the gas in which the experiment is performed, the pressure under which the experiment is conducted, and the history of the plate previous to the experiment.

Mr. Smith proposed to call these pictures "inductoscripts," a name which somewhat suggests the nature of the process without being hybrid in construction. The paper in which he describes his experiments may be consulted in the *Proceedings of the Physical Society*, vol. xi., part iv., pp. 353-356.—*Electrical Review.*

LINEN BLEACHING.

PEROXIDE of hydrogen is water slightly acidulated and containing an extra strength of oxygen. The combination of hydrogen and oxygen was found to produce peroxide of hydrogen so far back as 1818; but its practical application as a bleaching agent was greatly impeded by the cost, and the inability to produce it in such a form that it could be used when required, and in sufficient quantity for all varieties of cloth and yarns. It may safely be asserted that no chemical element approaches so near perfection for general bleaching purposes as peroxide of hydrogen; but it depends wholly upon the amount of oxygen which it can hold in solution for its valuable properties. It is the evolution of the oxygen which gives the bleaching action, because it is brought into contact with the coloring matter of the fibers, which it oxidizes and removes without injury to the materials; this is the principle of the old linen bleach which sun and air produced, and repeated washings of the fabric increased the whiteness. This is exactly what occurs in bleaching with the peroxide of hydrogen, with this distinction, that the concentrated agent is held in solution with the water. In the old practice the oxygen was more widely diffused by the combined action of the air and the sun's rays. By the artificial process of bleaching, one operation of a few hours gives results almost equal to months by the natural method. Water has two atoms of hydrogen with one of oxygen, and is known in chemical language as oxide of hydrogen, formula H_2O; peroxide of hydrogen as a bleaching agent has two atoms of hydrogen with two atoms of oxygen; so that the formula becomes H_2O_2, showing an extra atom of oxygen. The production of this compound is a very complicated process. The oxide of barium is made to absorb oxygen from the air, which becomes dioxide of barium; this, in combination with water, gives up the oxygen and forms the peroxide. The oxygen of the solution, being very slowly set at

liberty, penetrates in every direction, and will attack any matter that it has an affinity for, or it will escape into the air. Of all other matter, it has a particular affinity for the coloring substance in textile fibers, and by oxidation transforms the character of the coloring pigments to be bleached without any residue remaining after the goods are finished; other bleaching agents leave traces in the fibers, however careful the washing may be, and to the detriment of the materials operated upon. A clear white must give better effects for the dyeing process; the colors will be more fixed, as the fiber is in a better condition to absorb the dyes. In the action of peroxide of hydrogen, the original color of the fiber or fabric is not merely incased with a fine white matter, but it is completely removed, so that no chemical reaction can follow; of course if the coloring matter is very dark, more oxygen will be required. One of the objections against this powerful bleaching agent is the time it takes to operate; but this is really much less than is generally supposed. If a tank is constructed sufficient to hold one half ton of goods, with room to allow the liquor to circulate freely through them, the operation can be completed in twelve hours, without fumes, steam, or vapor. Again, a decided advantage in this bleach is that the operatives have complete control over the goods by changing the time in the bath, or its strength, and may easily tell how much has been accomplished. Great improvements have been made in the manufacture of peroxide of hydrogen, and, speaking up to date, it is now possible to produce it at such a cost as to be very little over the outlay under the present system. If the damage done to machinery, etc., where lime and acids are employed be duly considered, the economy in the use of peroxide of hydrogen would become obvious without any dispute. There is one form of it, called perozone, prepared so as to overcome the want of stability, uniformity, and other defects. It is portable, and can be sent any distance without the quality being impaired.

The method of using it is extremely simple. The tank in which the goods are placed must be free of all metal fixtures (lead and antimony are the only metals that will not decompose the solution). For 112 lb. of yarn 1,500 lb. of water, with 500 lb. of perozone, are put into the tank; 5 lb. of silicate of soda 30° B. are dissolved in boiling water in a separate vessel and poured into the bath, which is then thoroughly stirred up. The yarn, after being well scoured, is entered and distributed evenly; the tank being covered with a cloth to keep the dust and dirt out, is left in this condition for twelve hours, when the yarn is taken out, rinsed, and finished. The bath can be preserved for an indefinite period, and for further lots of goods from 9 to 12 lb. of perozone are added, with 2 or 3 oz. silicate of soda dissolved as stated above; about one ounce of the silicate may be allowed for every 6 lb. of perozone; the bath is thus maintained at the same strength. It may be as well to remark that the goods would be better moved about once every two hours. Piece goods can be run similar to the simple dyeing machine, rollers and bearings being of wood. Any method of operation which circumstances may indicate can be employed; but sufficient silicate of soda must be used, so that the bath may be slightly alkaline; the perozone is in a small degree acid. This prevents the decomposition and escape of oxygen; therefore, when some portion of alkali is added to it, the contact with foreign matter is sufficient to release the oxygen. The silicate of soda is the best of all alkaline bodies, as it is not so volatile as ammonia, nor likely to cause a too rapid evolution of the oxygen, by which the larger quantity is lost by escaping into the air. When the bath is not in use, it must be kept covered; there will be little or no action, and it can be preserved for use when desirable. A most desirable method for very fine goods, giving a satisfactory white color, is as follows: For 550 yards of cloth, steep in cold sulphuric acid about 3° Tw. until thoroughly impregnated, then take out and allow to lie in a heap for ten or twelve hours, afterward well wash, and boil for six hours with 220 gallons of water, 22 lb. dry caustic soda 72 per cent. (Brunner's brand), 66 lb. of soap, 11 gallons of hydrogen peroxide 12 volumes, and 17 lb. of calcined magnesia; after washing, sour through the sulphuric acid as in the first instance; wash again and dry. This process gives a finer and clearer white than by the ordinary use of the peroxide.

BLEACHING COMPOUNDS.

A German patent gives turpentine as a principal constituent in a composition known as "Ozonin" as follows: Hard soap, 125 parts; turpentine, 200; caustic potash, 22·5; water, 40; hydrogen peroxide, 90. The hard soap is dissolved in the turpentine, then the potash is dissolved in the water mixed with hydrogen peroxide, and then with the soap mixture; in the course of a day a stable mass is formed. Some useful properties are claimed for this substance.

This patent has been lately modified, and consists of 22 parts hydrate of potash, 128·5 parts of water, 125 parts colophony (which is a dark colored resin obtained from turpentine), 150 parts turpentine, 128·5 parts peroxide of hydrogen; the water, colophony, and potash are boiled together, then the turpentine is stirred in, and lastly the peroxide of hydrogen is added; this compound is said by users to be superior to peroxide of hydrogen alone, or an emulsion made of resin, potash, and turpentine. The patentee claims that equal quantities of an indigo solution were bleached by 5 drops of "ozonin" in half an hour, by 10 drops of peroxide of hydrogen in 48 hours (a wide difference in time), and by 5 drops of the turpentine emulsion in 12 hours. One part of "ozonin" in 1,000 parts of water is said to give a powerful bleaching solution, capable of bleaching all kinds of textile fabrics and other products without attacking the fiber. This must certainly be the *ideal bleach* so long, anxiously, and expensively sought for; further experiments may cease, and bleachers rest content from their difficulties if only a portion as stated is actually practical outside of a laboratory.

A German bleaching process is based upon the reaction which takes place between the red prussiate of potash (potassium ferrocyanide) and hydrogen peroxide in the presence of caustic potash; oxygen is thus liberated, and yellow prussiate of potash formed. Without entering into further details, we may point out the great cost from the expensive character of the agents; besides, the fabrics will be liable to a peculiar tinge of blue, through the decomposition of the yellow prussiate leaving its traces within the cells of the fibers.

We must, however, hasten to a conclusion of our remarks on linen bleaching. The bleaching quality of perozone depends entirely upon the most powerful and perfect agent in nature. It may be said to be the same agent which, working under natural laws, brings about the same results in bleaching. Prudhomme discusses the action that takes place when magnesia is used with peroxide of hydrogen, and comes to the conclusion that it is a superior combination, being a more stable compound. In all bleaching operations, whether the natural grass bleach or by means of chemicals, the principal point is in the treatment of the lye; pure materials of a proper standard are of the utmost importance, in fact a necessity; then proper temperatures require careful attention; steeping and cleansing are also points where judgment and skill in the nature of the materials are desirable. The utmost exactitude in proportions and preparation of a bleach bath may be rendered nugatory by imperfect boiling, steam not being sufficiently powerful, or too much condensed water, and many other minor defects owing to *hurry* and *scurry*, which result in loss at the end. In former papers we have alluded to water, its requisite purity, etc. Where soft water is difficult to obtain, it is good practice to make the chlorine bath for bleaching and the bluing process with condensed water if possible. Bleaching is the subjecting of a fibrous material to various operations in succession. Oxygen has the power of destroying organic coloring matters. Ozone is frequently present in the atmosphere, and it is supposed that the bleaching of fibers exposed to the air is due to its influence. Chlorine is an oxidizing agent acting indirectly, so that the *unknown element* of a bleach is generally considered to be the effect of oxidation. Chlorine has a peculiar attachment for hydrogen, and has the power of replacing it by substitution. It is supposed the chlorine extracts the hydrogen from the water, setting free the oxygen, which seizes the coloring substance in the fiber, producing a colorless compound, more so in the fiber of flax than in any other vegetable textile. During the retting or fermentation of the flax plant, a coloring substance is formed which attaches itself to the fibers, and is insoluble in acids, boiling water, or alkalies, but after exposure to the air, sunlight, and moisture becomes soluble to the influence of alkalies or chlorine; the amount, therefore, of this coloring matter is greater than in cotton, so that it loses more weight in bleaching, which is a tedious process. We have not exhausted the subject of linen bleaching; much more could be said, but it is necessary to come to a conclusion, and we trust that what has been written will evoke a spirit of inquiry into the various experiments we have from time to time alluded to in the past issues of this journal.—*The Irish Textile Journal.*

THE MANUFACTURE OF LIQUORS AND PRESERVES.*

By J. DE BREVANS, Chief Chemist of the Municipal Laboratory of Paris.

CHAPTER II. (*Continued.*)

SECTION X.—COMPOUND SIRUPS.

COMPOUND sirups are those which are prepared with several aromatic materials and simple sirup made from sugar.

Preparation of Compound Sirups.—All aromatic materials may serve in their preparation, no matter what their condition may be, whether in the form of juice, waters, essences, spirits, etc. The preparations which may be grouped under this head are very numerous. The following are examples:

Absinthe.
Crème d'Absinthe.

Essence of absinthe	8 drops.
" " cinnamon	1 drop.
" " rose	1 drop.
Sugar	400 grm.
Alcohol	500 c. c.
Water	500 c. c.

Product, 1 l.

Gum Arabic (*Acacia Arabique*).

Tree (Fig. 39) is 7 to 20 feet in height, roots hard, ligneous and have many ramifications. Trunk

FIG. 39.—GUM ARABIC.

straight, brown bark, yellow sap, wood hard. Leaves alternate, flowers yellow. Fruit long, smooth shell, russet to brown. Seeds round and smooth.

* Continued from page 14306, SUPPLEMENT No. 889.

Sirup of Gum Arabic.
Sirop de Gomme Arabique.

Refined sugar	5 k.
White gum arabic	600 grm.
Water	2 l. 900 c. c.
Whites of four eggs.	

Wash the gum and dissolve cold in 600 c. c. of water. When the gum is dissolved, pass the solution through a fine sieve of linen and mix with the boiling sirup, which is preferably clarified. Boil for two or three minutes and pass the sirup through a linen straining bag.

Formula of the Codex

Gum arabic	500 grm.
Cold water	508 grm.

Stir to effect solution and pass through a blanket and mix with:

Boiling simple sirup	4000 grm.

Almonds.
Sirop d'Orgeat (*Codex*).

Almonds, sweet	500 grm.
" bitter	150 grm.
White sugar	3000 grm.
Distilled water	1625 grm.
Water of the orange flower	250 grm.

Cleanse the almonds, remove the skin and make a paste of them in a Wedgwood mortar with 750 parts of sugar and add little by little 125 parts of water. Dilute the paste exactly with 1,500 parts of water and pass through a linen bag. Take up the residue with a little water, so as to obtain 2,250 grm. of emulsion, in which dissolve, on the *bain marie*, or water bath, the remainder of the sugar. Add the orange flower water to the surface of the sirup when it has cooled, then mix.

Balsam of Tolu.
Sirop de Baume de Tolu (*Codex*).

Balsam of tolu	50 grm.
Distilled water	1000 grm.
Sugar (white) sufficient quantity.	

Digest the balsam of tolu with a small quantity of water for two hours over a covered water bath, stirring frequently. Decant the solution and replace the water by a second portion and proceed as before. Reunite the product of the two digestions, let it cool and filter through paper. Add the sugar in proportion of 180 parts to 100 parts of liquid. Make a sirup by simple solution in the covered water bath and filter through paper.

Coffee.
Sirop de Café.

Coffee, browned	5 k.
Simple sirup	4 k.

Exhaust the coffee by a quantity of boiling water sufficient to obtain 10 l. of infusion. The sirup is boiled until it has lost a quarter of its weight, which is replaced with water to make up for that which has been evaporated. Mix thoroughly and filter.

Camomile.
Camomille Romane.

Small plant (Fig. 40) in tufts, velvety stems, attains a

FIG. 40.—CAMOMILE.

height of 20 inches, leaves alternate, sessile, well separated, flowers yellow center, white body, bitter taste, agreeable balsamic odor.

Sirup of Camomile.
Sirop de Camomille (*Codex*).

Dry flowers of the camomile	100 parts.
Water	1000 parts.
Sugar	1 k. 900 grm.

Make an infusion with boiling water; allow the mixture to macreate for six hours, pass through linen, allow it to repose and add the sugar. Let it dissolve in a covered water bath.

In the same manner the sirups of absinthe, hyssop, etc., are made.

Capillaire (*Adiantum pedatum*).
Capillaire du Canada.

Long stem (Fig. 41), leaves 3 to 5 decimeters long, small leaves of a bright pure green. More aromatic than the capillaire of Montpellier.

Capillaire Sirup.
Sirop de Capillaire.

Fine white sugar	5 k.
Canada capillaire	250 grm.
Pure water	2 l. 600 c. c.
Whites of four eggs.	

Infuse two-thirds of the capillaire for two hours in 1 l. 800 c. c. of boiling water, add the sugar; after all has been passed through a sieve clarify with albumenized water. Pour on the boiling sirup to the remainder of the leaves, infuse for two hours and strain through a linen bag.

The sirup of capillaire can be perfumed with the addition of 12½ grm. Pekao tea during the infusion in the boiling sirup. When it is necessary to employ the

capillaire of Montpellier, the amount of the capillaire must be increased by one-third.

Cherry Sirup.
Sirop de Cerises.

Refined sugar	5 k.
Conserve of cherries	2 l. 600 c. c.

Put the filtered conserve in a basin, heat quickly and remove as soon as it boils. Remove from the fire, allow it to rest and skim. Pass through a blanket or filter.

When the sirup is made in the cherry season the conserve is dispensed with and the operation is as follows: Well ripened cherries are stoned and pressed. The juice is allowed to stand 24 hours, then decant and filter. Then the operation is performed as above.

FIG. 41.—CANADIAN CAPILLAIRE.

Lemon.
Bichof Froid.

Infuse the skin of a lemon in a glass of *kirsch.* When it has absorbed the perfume remove it and pour the kirsch into 2 l. of white or red wine in which a pound of sugar has been melted.

Raspberry.
Sirop de Framboises.

White sugar	5 k.
Conserve of raspberries	2 l. 600 c. c.

Same operations as in making currant sirup.

Another Receipt.

Sugar	5 k.
Ripe raspberries	5 k.

Put the fruits in a copper basin with the sugar and boil until the desired degree of thickness is obtained. Pass through a linen bag.

Sirup of Raspberry Vinegar.
Sirop de Vinaigre Framboise.

White sugar	1 k.
Raspberry vinegar	500 grm.

Put the sugar in an earthenware vessel, add the sugar, stop up the vessel tight and heat gently over a water bath; when the sugar is dissolved remove it from the bath, cool off the sirup and bottle.

Raspberry Vinegar.

Fill a jug or crock with ripe raspberries and cover with vinegar. At the end of two months decant the clear liquid and preserve in bottles.

Currant.
Sirop de Groseilles Framboise.

Refined sugar	5 k.
Conserve of currants	2 l. 600 c. c.

Put the sugar in a basin, put on the conserve, heat quickly, stirring constantly. Remove the sirup from the fire and allow it to repose for an instant; skim if necessary. Pass through a filtering bag. Sirup of wild cherry is prepared in the same manner.

Marshmallow.
Sirop de Guimauve.

Refined sugar	5 k.
Dry powdered marshmallow root	500 grm.

Melt the sugar on a water bath with gentle heat; keep covered; when the sugar is entirely dissolved cease the heating and filter, after which the sirup is cooled.

Lemon.
Sirop de Limon.

Refined sugar	5 k.
Concentrated essence of lemon	50 c. c.
Citric acid	40 grm.
Water	2 l. 600 c. c.
Whites of four eggs.	

Cook and clarify the simple sirup, pass through a filtering bag, then add the essence of lemon and the citric acid dissolved in 1 l. of water. Stir briskly, mix, and when cool bottle.

Mulberry.
Mûres.

The black mulberry (Fig. 42) is a tree 25 to 45 feet high, fruit round and plump, red and black.

White sugar	5 k.
Mulberries	5 k.

Take fruit which is not quite ripe, put in a basin with sugar. Carry the mixture to the boiling point

FIG. 42.—BLACK MULBERRY.

or until the sirup is concentrated enough, then pass through a filter.

Walnuts.
Sirop de Noix.

Walnuts	120 k.
Brandy	10 l.

Infuse the green nuts gathered at the end of July in the brandy. Throw in 5 grm. each of cloves, cinnamon, musk and coriander. In December filter the infusion and mix with a sirup prepared with 3 k. 750 grm. of sugar. Leave the mixture for fourteen days, filter and bottle.

Orange Flower.
Sirop de Fleurs d'Oranger.

Refined sugar	5 k.
Orange flower water	500 c. c.
Water	2 l. 100 c. c.
Whites of four eggs.	

Dissolve the sugar with 1 l. of pure water and 600 c. c. of albumenized water and clarify; strain, add the orange flower water, mix and cover. Sirup of roses is prepared in the same manner.

Ratafia of Orange Flowers.
Ratafia de Fleurs d'Oranger.

Prepare a bed of orange flowers on a deep plate, then add a layer of fine sugar, then a layer of flowers, and so on, leaving a layer of sugar at the top. Cover and leave in a cool place for 12 hours. Wash the mixture with water and add the alcohol. Leave the liquor for a month, then filter.

To prepare the ratafia the following proportions should be used:

Petals of orange flowers	100 grm.
Sugar	750 grm.
Alcohol (85°)	600 c. c.
Water	400 c. c.

In the same manner the ratafias of rose, jasmine, etc., are prepared. For the ratafia of acacia flowers it is necessary to employ 1,500 grammes of clean flowers.

Sirup of Orange.
Sirop d'Oranges.

Refined sugar	5 k.
Concentrated essence of orange	50 c. c.
Tartaric acid	80 grm.
Water	2 l.
Whites of four eggs.	

Same process as that used in making lemon sirup.

Sirup of Orange Peel.
Sirop d'Ecorces d'Oranges (Codex).

Fresh orange peel	90 parts.
Water	100 parts.

Infuse for 24 hours. Press and dissolve in the infusion, double its weight of sugar.

Bitter Sirup of Orange Peel.
Sirop d'Ecorces d'Oranges Amères (Codex).

Dry peel	100 parts.
Alcohol (60°)	100 parts.
Water	1000 parts.

Macerate for 12 hours in alcohol. Throw on all the water in a boiling state and leave the infusion for 6 hours. Press, filter, add 190 parts of sugar to each 100 parts of liquid. The operation should be conducted in a covered water bath.

Punch.
Sirop de Punch au Cognac.

Brown sugar	5 k.
Cognac	3 k.
Concentrated essence of lemon	1 c. c.
Citric acid	6 grm.

The sugar is clarified and cooked to 32° and filtered and put in a vessel with the cognac. The essence of lemon and the citric acid is dissolved little by little. The whole is mixed and the vessel is carefully closed and shaken anew until entirely cold.

Punch au Kirsch.

Refined sugar	5 k.
Kirsch	2 l. 50 c. c.
Alcohol (85°)	400 c. c.
Essence of apricot	100 c. c.
Essence of lemon	1 c. c.
Citric acid	6 grm.

Same method as that given above.

Rum Punch.
Sirop de Punch au Rhum.

Refined sugar	5 k.
Rum	2 l.
Alcohol (85°)	1 l.
Essence of lemon	1 c. c.
Citric acid	6 grm.
Hyson tea	25 grm.

Prepare a strong infusion of tea with 400 c. c. of boiling water and add the sirup cooked to 36°. The rest of the operation is the same as before.

Four Fruits.
Sirop des Quatre Fruits.

This name is given to equal parts of the sirups of cherry, strawberry, raspberry and currant.

Tea.
Thé.

The tea plant of China (Fig. 43) attains a height of

FIG. 43.—CHINESE TEA PLANT.

3 to 7 feet. Leaves alternate oval, elongated, pointed and of a deep green color. Fruit green and plump. The leaf is the part utilized.

Sirup of Tea.
Sirop de Thé.

The sirup of tea is prepared in the same manner as capillaire sirup, with the following materials:

Tea, Imperial	100 grm.
Tea, Pekao	25 grm.
Pure water	2 l. 900 c. c.
Whites of fifteen eggs.	

Wash the roots with tepid water; boil them for 20 minutes with 2 l. of water. Pass through a sieve without pressing; add sugar to the infusion and clarify. To perfume add 25 c. c. of orange flower water.

Vanilla.
Sirop de Vanille.

Vanilla	60 grm.
Sugar	500 grm.
Brandy (45°)	24 grm.
Water	310 c. c.

Cut the vanilla longitudinally, then transversely as thin as possible. Triturate in a mortar, adding alternately a little sugar and a little brandy to make a homogeneous paste. The mixture is introduced in a vessel with the remainder of the sugar and the water. Dilute the white of an egg with as little water as possible and mix. Place the vessel on a water bath and heat; at the end of 24 hours strain.

Violet.
Sirop de Violettes.

Refined sugar	5 k.
Fresh flowers, crushed	525 grm.
Water	2 l. 600 c. c.

Contuse the violets in a mortar put in a tinned water bath. Add 1 l. of water (60° C.) Agitate some time and press the flowers. Put them back in the tin water bath; throw on the rest of the boiling water; infuse for 11 hours; pass through wet linen.

Preservation of Sirups.

Sirups change easily. They ferment or become mouldy. To prevent this loss recourse is had to various systems, of which the best, as it introduces no foreign elements into the liquor, is the Appert process. The bottles of sirup are heated over a water bath to between 60° and 70°, as has been already described for fruit juices.

(*To be continued.*)

DETECTION OF GOLD IN DILUTE SOLUTIONS.

By T. K. ROSE, B.Sc., Assistant Assayer to the Royal Mint.

IT is well known that if large quantities of boiling water are poured into a solution of stannous chloride, a yellowish white gelatinous precipitate of tin hydrate is obtained. If the water contains a little chloride of gold, the precipitate is colored red (purple of Cassius). A solution of one part of gold per million parts of wa-

ter treated in this way gives a bright rose-colored precipitate almost instantaneously in a small test tube. One in four millions gives a paler color easily detected in a test tube, if comparison is made with the precipitate caused by distilled water. For more dilute solutions a greater bulk of liquid is required, and the precipitation is best effected in beakers.

If 0·0000311 grm. gold (one-millionth of an oz. troy) is dissolved in 3·11 liters of water, and the solution, containing one part per hundred millions, is raised to boiling and poured suddenly into a large beaker containing 10 c. c. of a saturated solution of $SnCl_2$ in water acidulated by HCl so as to mix the two liquids as rapidly as possible, a bluish purple precipitate is obtained. This precipitate, when collected in a test tube, differs markedly in color from a precipitate obtained by pure water in the same way. There seems no reason why a still more dilute solution of gold should not yield a color if precautions are taken to insure the complete mixture of precipitant and solution.

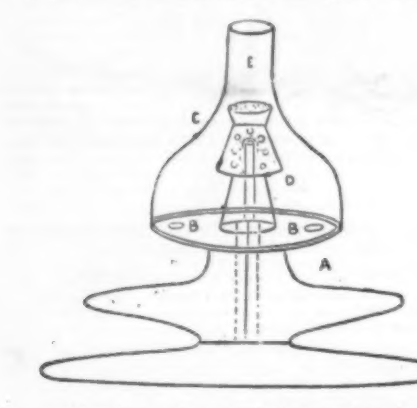
Quantitative results based on comparison may also be obtained with care, as the precipitates are quite stable in water. The presence of NaCl (3 per cent.), $CaSO_4$, KCl, KBr, NH_4Cl, a little free HCl, etc., or all of these, does not interfere with the reaction. The precipitate is soluble in ammonia and is reprecipitated, showing its original color, on neutralizing with HCl. Synthetically prepared sea water containing gold to the amount of one in twenty millions (three-quarters grain per ton) is equally sensitive, but the color is in this case a blackish rather than a purple violet. I am proceeding to test real sea water in the same way, though quantitative results cannot be expected, since Sonstadt states (*Chemical News*, xxvi., p. 159) that only a small portion of the gold present is precipitated by stannous chloride.

This modification of a very well-known test appears likely to be useful in chlorination mills, where it is often desirable to detect the presence of gold in liquids containing as little as 1 in 5,000,000. The most dilute solution that reacts if treated in the ordinary way by $SnCl_2$ is one per million (*vide* text books, *passim*), and then only after a lapse of some hours.—*Chem. News.*

DETECTION OF GASES WHEN ADMIXED WITH AIR.

THIS particular form of gas apparatus, which was brought out early this year, by Mr. N. H. Warren, is intended mainly for the detection of suspected escapes of coal gas when in confined spaces, such, for instance, as private houses, laboratories, etc. Mr. Warren, in calling attention to the device, says:

Experiments with a view of studying more closely



the condensing action of platinum when in various forms of division were the chief motives which led to the construction of the same. Thus, if asbestos, for convenience sake, in the form of yarn, be introduced into solution of platinic chloride, and, after drying, ignited in a closed crucible, the substance, as is well known, has conferred upon it the property of condensing gases upon its surface, due to the impregnation of what is known as platinum black. This method of rendering asbestos sensitive is, however, attended with several inconveniences, both on account of the disengagement of acid vapors during ignition, thus rendering the texture rotten, and, at the same time, retarding the surface action by the formation of magnesium salts. To obviate these difficulties, the writer has substituted for platinic chloride that of the oxalate, and by so doing has obtained a modified action of peculiar sensitiveness. This compound is readily procured by saturating asbestos yarn, of finest quality, with a strong solution of platinic oxalate, obtained by dissolving the hydrate of that metal in oxalic acid, and, after drying, igniting the same in a porcelain crucible. If a sample of so prepared asbestos be now introduced into a mixture of hydrogen and oxygen gases, combination at once takes place, accompanied by the usual phenomenon; but if the said mixture be now substituted by one of coal gas, no action is the result. Withdraw now the sensitive wick and heat to 80° F., and replace the same in the mixture; quite a different result is at once obtainable, the wick becoming speedily raised to incandescence, and this continues as long as the faintest trace of mixed atmosphere remains. So sensitive, in fact, is the reaction that 0·5 per cent. by volume of coal gas or other hydrocarbons, when in admixture with the atmosphere, is at once readily detected.

The subjoined illustration, representing a section of the apparatus when in use, will perhaps serve to more clearly explain the same, A serving as the base or reservoir of the lamp, and containing petroleum spirit which is employed as a fuel for the same, and surmounted by a gallery running round the upper part and pierced with two apertures at B B, intended to collect the air required, when applying the chimney, C. In using the apparatus the wick, consisting of platinized asbestos, is first inserted in its holder and a light applied to the same. The flame caused by the combustion of the petroleum spirit may be now conveniently extinguished, leaving the uppermost portion of the wick red hot, which continues to flow while any petroleum spirit remains in the reservoir. While the wick is thus still flowing there is placed over it the copper thimble, D, which is perforated with numerous small holes, and containing a further coil of platinized asbestos, E, in close proximity.

The reaction may thus be minutely explained: The heated asbestos, fed by the petroleum spirit, naturally produces sufficient heat to maintain the second coil, E, at the required temperature of which has already been stated. If the so prepared lamp be now introduced into a room where an explosive atmosphere is prevailing, the glass chimney at once samples the atmosphere by causing an upward draught, which, passing over the heated coil, immediately raises the same to incandescence.—*American Gas Light Journal.*

A WRITER in the *Country Gentleman* speaks of the advantages of the hydraulic ram for forcing water in small running streams into a house. He says that the ram will throw water 10 feet for every foot of fall. A small pipe only is required. Where there is a very small running stream a ram may be used to advantage, for it is self-acting, works day and night, and rarely gets out of order.

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